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Cables :: "Stomata." | Phone :: 2183.

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THE CACAO INDUSTRY.

'THE whole concept of economics presupposes above all else balance between production and consumption'. Never has this axiom become so prominent in the cacao industry as during the last few years. Depressions have occurred periodically throughout its history but the present crisis has, through coincidence with general world depression, assumed dimensions so far above the previous ones that many cacao producing countries are seriously alarmed about the future of the industry. This is particularly the case in those countries which grow a 'fine' product.

The trend of the industry during the last 30 to 40 years may be gathered from the following summary of production and consumption statistics. In 1895 world production in metric tons of raw beans was estimated at 76,933. This increased at a rate of between 4¼ per cent. to 8½ per cent. per annum (compound interest) till 1927 when production reached a figure of 487,054 metric tons. From 1928 to 1933 the rate of increase was slower, averaging for the six years only 2⅜ per cent. per annum. Consumption during the period 1895 to 1927 kept on the whole abreast of production and a little excess of production in one year was absorbed by a slight scarcity in the following. During the last six years consumption has increased only at the rate of an average of 1 7/16 per cent. per annum. Consequently there has been a surplus of raw beans which has steadily risen for a period of six years. This surplus production has consisted largely of beans of the poorer qualities of cacao and has caused a drop in the *basic* prices of the commodity to an unprecedented level. The market value of fine cacao has also dropped to a corresponding degree and in countries which rely on a price premium for this mark the return is now below the minimum cost of production. Moreover in the most important fine cacao countries witchbroom disease is rapidly killing the trees (chiefly through neglect caused by low prices) while there are still some areas where a low grade cacao can be grown, crudely prepared and placed on the market at a very low price if desired.

In the early months of 1933 the situation in West Africa and other major producing countries was becoming serious and in Trinidad it was further aggravated by incidence of disease. Low prices could only be offset by economy in cultivation and preparation which in its turn meant lower yields and an inferior product. Smaller

returns caused still further economies until the point was reached when the beans could barely be harvested from the trees. Trinidad received no margin for witchbroom control which was calculated to need an expenditure of at least $5.00 per acre. Faced with continued low prices and bankruptcy, representations were made to the Trinidad Government calling attention to this state of affairs and a scheme was suggested to control selling prices provided all the main producing countries could be induced to co-operate. The scheme was accepted in its entirety and forwarded to the Secretary of State for the Colonies. After investigation, His Majesty's Government decided that the situation was indeed critical and consultations were arranged with the Colonial Governments concerned and representatives of the cacao trade and of the users of raw cacao in the United Kingdom with a view to calling a conference to discuss the matter at an early date. The whole matter has now been referred to Geneva.

The points on the agenda for discussion by producing countries are:—(*a*) Whether they should co-operate to raise the world price of cacao to a more remunerative level by introducing a greater measure of co-operation in marketing between the producers and by adopting an orderly but flexible programme for expanding the production of cacao as demand increases; (*b*) Whether such co-operation would be facilitated by the creation of a small international body to study all available information regarding the production and consumption of cacao, and other cognate matters; and (*c*) Whether it is necessary in order to overcome the present temporary crisis due to excess stocks, to create a fund to hold some part of these excess stocks off the market.

His Majesty's Government agree that unless surplus stocks are held in secure hands until there occurs an increase in consumption which is not accompanied by increase in production they will continue to overhang the market and depress prices. There must also be some international agreement between sellers concerning prices and the Liverpool price of Accra is suggested as a basis. It is quite clear however that the general advance in prices which must take place can only be small. This will tend to prevent extensive replanting and will not be sufficient to effect a decrease in consumption. Too high a price would lead to an immediate upset in the equilibrium balance between supply and demand.

Of the numerous schemes suggested there are only two which will be considered here. The original "Z" scheme submitted by Trinidad provided for the creation of a pool of cacao in bond. This pool was to be composed of a random sample of each growth in amounts calculated to raise the market to a pre-determined price, when inflow to bond would cease. 'Production' would then be below consumption and any further increase in price would be counteracted by releasing sufficient supplies from bond to restore the market price to the desired level. In this way the pool would prevent speculation and undue rise in prices but would tend to ensure a basic price calculated to be just sufficient to maintain the industry. In the event of prices failing to reach the predetermined level bond supplies at certain periods should then be pressed for oil and destroyed. Like restriction schemes in other commodities it was essential to obtain complete co-operation between all producing countries.

The "Omega" scheme suggested that all new plantings should be destroyed and the owners compensated from an export tax levied on cured beans. Restriction of supply was allowed for by Government purchase of Intermediate crop at a fixed price for destroying.

Both schemes have been criticised in that beyond their purely artificial nature they leave loopholes of escape. Doubtless this was the point in view when a clause for the 'Foods and Drugs Purity Act" was suggested to ensure that all products under the names of chocolate confectionery should contain not less than a fixed amount of cacao products of a definite standard of purity. Without some clause of this nature the consumer might react against increase in prices by using a very much adulterated product or a thinner coating of cocoa mass over his confectionery.

It is evident that under these and most of the other schemes suggested the producer is ultimately being compensated at the expense of the consuming public and where one benefits the other loses. Clearly some scheme should be evolved which will safeguard both. Thus there appears to be a definite need for co-operation between growers to sell direct to leading brokers or manufacturers instead of selling to shopkeepers and small merchants. It has been argued that there is theoretically only one legitimate middleman, the manufacturer, between the producer and the consuming public. That there should be collectors on the one hand and distributors on the other however is essential for smooth running of the industry though a long string of the one or of the other is not justified, taking as each must, some remuneration at the expense of the producer in times of plenty and of the consuming public in times of scarcity. Also in times of plenty the consuming public considers itself entitled to the best of the commodity available. The two schemes outlined above call for the suppression of a *random* sample of cacao equal to the amount of world surplus. This throws the burden of restriction schemes on to the consuming public for they receive no benefit in exchange. If only the inferior beans, judged from the point of view of size or purity, were removed in this manner, benefit would accrue to all concerned. To the producer it would provide an incentive for growing better quality cacao and for care in preparation, giving the careful planter a right to a premium for good work. To the manufacturer it would mean the assurance of a better quality raw material with less wastage for the better price he pays. To the consuming public it would mean the guarantee of a purer

and more wholesome foodstuff. To the research worker in the tropics striving continually to improve the efficiency of production, the quality and the purity of cacao, it provides a stimulus for his labours.

If the present tension can be effectively relieved it may be prophesied that the future of the industry will lie very largely with the research worker. Yields of cacao per acre are still very low in spite of experienced cultural practices. The reason is due to the relatively few efficient trees in the cacao field which can respond to treatment. While the average yield per acre of commercial cacao is at present about 3 to 4 cwt. per annum there do occur individual trees which consistently produce beans at the rate of 20 to 30 cwt. per acre calculated from the tree size and its performance, and statistics prove that in good years such trees pull relatively far ahead of the mediocre bearers. A number of these trees have been located and propagated but it will be many years before they form the bulk of the commercial population. Prices must rise to save the industry from immediate ruin but efficiency in production will safeguard the consuming public from any undue rise in the future and will reward the producer according to his labours.

EXPERIMENTS WITH BAGASSE CARBON.

By J. F. Williams, A.I.C.T.A.

I.—Introduction.

Plantation white sugar is usually manufactured in the cane factory by a sulphitation process, but owing to the gradual oxidation of substances bleached or reduced by the sulphur dioxide, these sugars seldom retain their colour and often undergo deterioration on storage. The use of vegetable carbons for decolourising juices or syrups as a substitute for sulphitation has been long advocated, and the literature on the subject is voluminous; there are, however, several decolourising carbon processes available with highly developed technique, for producing a very superior grade of white sugar direct from the cane. The outlay required for establishing such processes in a cane factory producing only a proportion of white sugar chiefly for local consumption is considerable, so that it would be an advantage if a cheap carbon could be prepared *in situ* from surplus bagasse.

Bagasse as a raw material for the production of decolourising carbon was first proposed by Weinrich (1) in 1891. In his patent he claims: "As a material for the filtration of sugar solutions, or other solutions or liquids, the fibre, crude or charred, of the described grasses, the stalks or stems of which have an internal marrow or pith", a claim which would include the use of charred bagasse. Later he found that charred bagasse was too expensive and preferred the finer fraction of the fresh material as a filter aid. Some twenty years later Clacher (2) calcined coarse bagasse in a retort and used the resulting char in the same manner as a bone-char filter; he stated that a good grade of white sugar could be made in this way, and that, unless in special circumstances, the carbon should not require purification. Should the latter be necessary, he recommended boiling the carbon with caustic soda and then with dilute acid.

Chaney (3) has advanced the theory that during the destructive distillation of vegetable matter, active carbon is first formed at low temperatures, but in virtue of its adsorptive properties, it takes up hydrocarbons produced at the same time, resulting in an inactive adsorption complex. Activation would therefore consist of the removal of these hydrocarbons from the base of active carbon by some process of selective oxidation. This is usually done by heating to temperatures not exceeding 1200°C. in a limited supply of air or in the presence of superheated steam. Working on this basis Coates (4) prepared an active carbon by subjecting bagasse to destructive distillation at 500-600°C., grinding the char and heating to 850-900°C. After boiling the product with 20 per cent. caustic soda and washing with hydrochloric acid, it was finally heated to 200°C. This carbon was found to be two and a half times as active as the best decolourising carbon then on the market.

Zerban (5) has also noted that better results are obtained by carbonising in two stages, that is, by first heating the material in an open vessel, and then in a retort which is nearly, but not quite air-tight, to a higher temperature. The activity of the carbon was found to increase as the temperature of the final heating was raised, though too high a temperature would lead to graphitisation and so a useless carbon. In observing the effect of impregnating the carbonaceous material prior to charring with substances such as alkali and alkaline earth carbonates and salts, chlorides of tin and zinc, &c., the mineral matter being subsequently removed by an appropriate solvent, Zerban concluded that the chemical nature of the raw material had only a small effect compared with that of the impregnating substance on the decolourising power of the resulting carbon. Bagasse by itself he found to give a poor carbon on account of its low ash content, but when carbonised with lime the product was much more active. Besides affording a framework on which the active carbon is deposited, and which, on removal, leave an exceedingly porous structure with capillary pockets of molecular dimensions, these inorganic substances appear to reduce the formation of the

adsorption complex of hydrocarbons on active carbon or to cause the decomposition of the adsorbed hydrocarbons (6).

It is doubtful, however, whether methods involving the use of some impregnating material with bagasse, such as lime, which would necessitate the subsequent treatment with acid, or the treatment of the char as recommended by Coates (*loc. cit.*), could be economically adapted to sugar factory practice in place of the sulphitation process. In the present investigation an attempt has been made to examine the possibility of utilising surplus bagasse for the production of a cheap, yet efficient carbon, and to determine the effect of different treatments on the degree of activity of the product.

II.—Experimental.

The general procedure adopted was firstly a preliminary charring of finely chopped bagasse at a comparatively low temperature, after which the mass was ground up and passed through a 100 mesh sieve. It was then subjected to bright red heat (900-1,000°C.) in a covered crucible in an electric furnace.

The charring was performed in an open saucepan over a bunsen burner, the bagasse being agitated with a mechanical stirrer, and in every case was continued up to the point where the evolution of thick pungent fumes gave way to less dense bluish smoke with no acrid odour. The definition of this change was found to be fairly sharp, and was taken as being an indication of the end-point in the destruction of the organic matter. The charred bagasse was then immediately transferred to a mortar, care being taken to extinguish any glowing lumps with the pestle as quickly as possible. The ground and sieved char was introduced into a large silica crucible which was completely filled and covered with a close-fitting lid, and heated in a furnace to a red heat for a definite period. After cooling, the crust of ash formed on the surface of the carbon was carefully removed.

The efficiency of the product was determined by adding a certain quantity to a 50 per cent. solution of a dark sugar (always in the proportion of five per cent. carbon on the weight of dry matter present), bringing the liquid just to the boil and filtering immediately under suction on a Buchner funnel. The colour of the filtrate as well as that of the original sugar solution was then compared on a Lovibond tintometer with the standard colour slides provided with the instrument. Invariably the solutions were examined in the one-inch cell and compared with the Series 52 standards. The amount of colour removed by the carbon was calculated by subtracting the value obtained for the treated solution from that of the original, and expressing the difference as a percentage of the value of the original sugar solution.

(*a*) *Effect of closeness of packing of the carbon in the crucible before heating.*—The extent of oxidation during the heating or activation will depend on the amount of air included in the mass of carbon in the crucible, and this, in turn, will depend on the closeness of packing of the carbon. As the process of activation consists of the selective oxidation of the hydrocarbons adsorbed on the active carbon, it was necessary to determine the mode of packing most suitable for the purpose. The effect of filling the crucible by lightly tapping down the carbon (loose pack) was compared with the result obtained by pressing the carbon down as tightly as possible (tight pack), heating in the furnace for six hours. The results are shown in Table I. It was found that the contents of the tightly packed crucible had hardly shrunk during the heating, while the loosely packed carbon had contracted to nearly two-thirds of its original bulk. Table I also shows the decolourising action of the char prior to activation.

Table I.

	Lovibond value.	Per cent. colour removed.
Original sugar solution	75	—
Unactivated char	56	25.3
Activated carbon, loose pack ..	15	80.0
Activated carbon, tight pack ..	54	28.0

The unactivated char removed 25 per cent. of the colour, while heating with a tight pack, or with a small amount of included air, produced a carbon removing only 28 per cent., hence little benefit, if any, has accrued under these conditions. Heating with a loose pack, however, produced a fairly active carbon, somewhat contrary to the findings of Zerban.

(*b*) *Effect of heating in the presence of steam.*—The ground and sieved char was suspended in water and separated on a Buchner funnel; the cake was sucked until it was dry enough to be crumbled. Again the effect of a loose and tight pack on this moist material was examined, heating for six hours as before. The results appear in Table II.

Table II.

	Lovibond value.	Per cent. colour removed.
Original sugar solution	75	—
Activated carbon, wet, loose pack	12.5	83.4
Activated carbon, wet, tight pack	55	26.7

Thus activation in the presence of superheated steam has increased the efficiency of the carbon under conditions of loose pack as compared with activation with air alone; no such advantage is gained with a tight pack when heated with steam. Steam activation, although producing a

better carbon, would, in a cane factory, necessitate the mixing of the charred bagasse with water and then filter-pressing, and the expense of this extra manipulation would hardly be justified.

(c) *Effect of duration of heating, and heating in two stages.*—It was found that the activity of the carbon obtained by heating for six hours with a loose pack was considerably increased on heating again for a further six hours. In order to determine how far this increase was due to the length of time of heating, the latter was carried out for 3, 6, and 12 hours on dry loosely packed char.

Table III.

	Lovi-bond value.	Per cent. colour removed.
Original sugar solution	75	—
Activated for 3 hours (dry, loose pack)	48	36.0
Activated for 6 hours do. ..	15	80.0
Activated for 12 hours do. ..	28	62.7
Double activation, dry, tight pack	18	76.0
Double activation, dry, loose pack	4	94.7

Table III shows that the best carbon resulted from a six-hour activation; possibly three hours was insufficient for the removal of the hydrocarbons while the prolonged heating for twelve hours tended to convert the active carbon into an inactive form. Heating in two stages, of six hours each, the carbon after the first heating being turned out into another crucible for the second heating, is shown to be definitely advantageous both for the loose and tight packs, though the superiority of the carbon produced from the loose pack is clearly established, and suggests a ready means for manufacturing active carbon in the factory. Practically the same result is achieved by heating once (six hours) with a loose pack as is obtained by heating twice with a tight pack.

(d) *Effect of chemical treatment of bagasse and of activated carbon.*—To determine the effect of impregnating the bagasse with lime before carbonisation as recommended by Zerban (*loc. cit.*) the bagasse was well mixed with milk of lime (ten per cent. CaO on the weight of dry bagasse), and after charring and heating for six hours the lime was dissolved out with dilute hydrochloric acid; after separating the carbon on a Buchner funnel it was finally washed with water. Zerban used equal quantities of lime and carbonaceous material, though the cost of this would be prohibitive in a sugar factory. The method of purification suggested by Coates (*loc. cit.*), consisting of boiling the activated carbon with caustic soda solution to remove silica, followed by washing with dilute acid and water, was also tested.

Table IV.

	Lovi-bond value.	Per cent. colour removed.
Original sugar solution	75	—
Activated carbon (single heating), untreated	15	80.0
Activated carbon (double heating), untreated	4	94.7
Activated (single) carbon, treated with NaOH and HCL ..	11	85.4
Activated (single) carbon, bagasse impregnated with 10 per cent. CaO	6	92.0

The results set out in Table IV, show that these treatments have been undoubtedly efficacious, especially where the bagasse was previously impregnated with lime, though a still more active carbon is produced by heating twice, without any chemical treatment of the raw material or carbon. This latter method, adapted to large scale practice, would probably be more economical as well. Some provision would have to be made for the preliminary charring, though subsequent activation could be carried out in the furnaces; it would not be necessary to have a special filter-press and other acid-resistant equipment for the purification of the carbon, though a filter-press for separating carbon from syrup would, of course, be required, if not already installed.

The once-used carbon was found to be still capable of further decolourisation, removing 78.7 per cent. of colour from the dark sugar solution.

Yield of carbon.—Starting with 100 g. of oven-dry bagasse, the following average amounts of carbon were obtained at the different stages:

25.1 g. ground and sieved char.
11.4 g. carbon, after first heating.
7.7 g. carbon, after second heating.

The final yield of carbon was found to vary in the several determinations from 5.5 to 9.8 per cent. bagasse.

Reactivation of the carbon.—After separating on the Buchner funnel from the sugar solution, the carbon cake was washed with water, sucked dry, crumbled, and heated in a crucible for six hours at red heat (loose pack). The reactivated product removed 96.7 per cent. of colour from the sugar solution, even more than the original carbon.

Action of bagasse carbon compared with Suchar.—The value of decolourising carbons is assessed not only by the amount of colour removed from solutions, but also by the speed of filtration, the effect on the purity and the final pH of the liquor being treated. In Table V are shown determinations of polarisation, purity, "glucose", pH, colour, specific electrical conductivity and surface tension of the original 50 per cent. sugar solution before and after treatment with the bagasse

carbon and Suchar. 163 c.c. of the solution were treated with 5 g. of carbon (giving a ratio of 5 carbon to 100 solids), and after being brought to the boil the whole was filtered under suction through a 5.5 cm. Buchner funnel. The solution treated with bagasse carbon passed through the filter in 2½ minutes, while an equal volume of the Suchar-treated solution took 6¾ minutes, nearly three times as long. In both cases a bright filtrate was obtained.

Table V.

	Original Solution.	Treated with 5 % bagasse carbon.	Treated with 5 % Suchar.
Pol per cent. ..	47.12	41.16	46.52
Brix	49.50	43.34	47.65
Purity	95.20	95.05	97.64
"Glucose" per cent.	0.35	0.65	0.86
Glucose ratio ..	0.74	1.58	1.85
pH	5.40	7.27	4.85
Lovibond colour, Series 52, 1 in. cell.	75	4	2.5
Specific conductivity, 29°C, mhos. ..	423×10^{-6}	651×10^{-6}	434×10^{-6}
Surface tension, dynes per cm., 29°C.	71	74	74

It was found necessary to wet the carbon with water before mixing with the sugar solution, which would account for the lower densities of the treated solutions. A very slight drop in purity was caused by the bagasse carbon, whereas an increase of over two points was obtained on treatment with Suchar, although in the latter case the amount of inversion (glucose) was greater. From the standpoint of colour removal Suchar proved to be somewhat better, although a drop of 0.5 pH was occasioned; bagasse carbon raised the pH of the liquor from 5.4 to 7.3. This decrease in the hydrogen ion concentration, although beneficial as far as inversion is concerned, militates against decolourisation (7), and is due to the basic character of the ash of the carbon, the dissolution of which is reflected in the increase in the specific conductivity of the solution. There is no doubt that pre-treatment of the bagasse carbon with dilute acid would give better results both as regards colour removal (since the liquor would be maintained on the acid side) and the concentration of salts, since any increase in the latter would increase the formation of molasses, though it is uncertain whether this added advantage would compensate for the expense and practical difficulties of acid treatment. The bagasse carbon on analysis was found to contain 17.97 per cent. ash, 22.87 per cent. of which was soluble in hydrochloric acid, as compared with 2.33 per cent. ash in Suchar. Removal of tension lowering bodies, as revealed by the increase in the surface tension of the treated solutions, was found to be the same for bagasse carbon as for Suchar.

III.—Conclusions.

A fairly efficient decolourising carbon may be prepared from bagasse by subjecting the latter to low temperature destructive distillation and then heating the ground char in two stages in a closed vessel to red heat for a period of six hours each stage. The ease of filtration of the final carbon would depend on the extent of comminution during grinding, and this should be just sufficient to give a bright filtrate; a powder passing through a 100-mesh sieve gave satisfactory results. The char should be packed lightly in the vessel in which heating is to be carried out so as to give adequate aeration for the oxidation of the hydrocarbons. Packing the char tightly gives higher yields of carbon, but the product is much inferior.

The carbon produced after heating twice was almost equal to Suchar in decolourising power, but it suffered from the disadvantage of possessing a high content of basic ash some of which was soluble in the liquor increasing its concentration of salts and imparting a slightly alkaline reaction. This difficulty could be overcome by extracting the carbon with dilute acid before use, though it is unlikely that such treatment would be profitable. After being used once the carbon was still capable of further decolourisation, and can be easily reactivated by heating again to red heat for six hours.

IV.—Acknowledgment.

The writer wishes to express his appreciation of the many facilities afforded him in this work by the Chemical Division of the Department of Agriculture, British Guiana.

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TUNG SEED MEAL.

W. Godden* has recently investigated at the Rowett Institute the possibility of using as cattle-feed the residual meal left after the expression or extraction of the oil from tung-seed. The meal although fairly rich in protein and carbohydrates, was unpalatable to poultry, dairy cattle and pigs. It was found to contain some irritant material which had a harmful effect on the mucous membranes of the intestine.

One cow in milk was given tung-seed meal mixed in to the extent of ten per cent. in the production concentrates, but this caused scouring. On the second day the milk yield was down half a gallon and the cow refused to touch the mixture again. Tung-seed meal thus appears to be unsuitable for feeding to livestock.

* The Feeding Value of Tung-seed Meal. W. Godden. *Bull. Imp. Inst.*, London, 1933, Vol. XXXI, No. 3.

THE GREAT SAVANNAH DISTRICT OF BRITISH GUIANA, WITH BRIEF NOTES ON THE VERTEBRATE FAUNA.

By Desmond Vesey-FitzGerald.

Apart from a comparatively small coastal strip the greater part of British Guiana is covered by a continuation of the great Amazon rain forest. At the head of the Rupununi river, however, there is a considerable area of savannah country, which is a continuation of the great savannahs of Northern South America. The writer visited this country during the dry season of 1932-33 (August-January), while travelling in company with Dr. J. G. Myers of the Imperial Institute of Entomology, on a search for insect parasites of the Trinidad sugar cane froghopper—*Tomaspis saccharina* Dist. A detailed study of the collections obtained has not yet been made. The object of the present article is simply to convey a few impressions of the conditions encountered in this little visited part of the Colony.

Any good map will show the main details of the district under consideration, but the exact course of the boundary between British Guiana and Brazil was only decided by the international boundary commissions at work during last year. The territories to be allotted to each of the three great countries of British Guiana, Venezuela and Brazil are decided largely by watersheds of the Essequibo, Orinoco and Amazon. The former British boundary with Brazil in this area followed the river Cotinga, but the present boundary is considerably further east, on the Ireng. Mount Roraima, well named by the Indians "Father of the Waters," since it sends water to each of these great river systems, becomes divided between British Guiana, Venezuela and Brazil, though formerly it was entirely British.

The approach to the savannah country was made through Brazil. After a lengthy journey to Manáos, and then through the rain forests of the Rio Negro, the expedition entered the Rio Branco. After a two days' journey up the Rio Branco, soon after crossing the Equator, the rapids of Caracarahy are reached. Approximately coincident with this rise in elevation is the commencement of the savannah. The Brazilian town of Boâ Vista, two days' journey above Caracarahy, is surrounded by savannah and redundant of the cattle industry. Hammocks are made of leather, and they look most uncomfortable. Sacks for provisions, and mats and curtains are made of hide with the hair on. Leather and raw hide articles are to be seen everywhere.

The Takutu river which at its confluence with the Rio Uraricuera, forms the Rio Branco, leads straight to the British border.

The great savannah district of British Guiana is drained by the Rupununi river, flowing north into the Essequibo, and by the Ireng and Takutu rivers, flowing south into the Rio Branco, an important tributary of the Rio Negro-Amazon system. The watershed between the Amazon and Essequibo is only eleven feet high in this district. The main savannah is only about 300 feet above sea level, but it is divided into a northern and southern portion by the Kanuku mountains. These mountains reach their highest point in Iramikipang which is about 3,000 feet. They are largely covered by tropical rain forest vegetation.

To the north-west, the foothills of the Pakaraima mountains meet the savannah, and the country rises in a series of plateaux, reaching its highest point at Mt. Roraima, which is 9,000 feet high. The Pakaraima foothills are characterised by rounded, savannah covered hills. A deciduous forest resembling Monsoon forest covers some of these hills, and rain forest fills the larger valleys. The Pakaraima mountains are typically flat-topped sandstone blocks, completely surrounded by sheer precipices.

The climate is comparatively pleasant owing to the prevalence during the dry season of an almost continual wind on the open savannah. The rainfall is not heavy, being about 40 inches. September to May is regarded as the dry season, the remaining months being wet. In the dry season, the grass dries up and there are extensive fires.

The grass *Trachypogon plumosus* and the shrub *Curatella americana*, locally known as the sand-paper tree, are the most characteristic members of the savannah vegetation. *Byrsonima crassifolia* and *B. verbascifolia* and a small *Paepalanthus* are constant associates of the above.

Certain "Islands" of raised land are dominated by Cashew Orchard. Lower areas, which are liable to flooding during the wet season, are covered by a mixed sedge vegetation. Definite hollows remain as lagoons or swamps throughout the year. The flowers of the Water Hyacinth are conspicuous on the lagoons. In the swampy areas, the stately Aete palms, *Mauritia* sp., are seen forming either islands of considerable size, or drawn-out belts following the course of some creek.

The struggling ranching industry, which is so severely handicapped by the remoteness of its market, supports a few white colonists. The remainder of the population consists of two tribes of aboriginal Indians: the Makushis north of the Kanuku and the Wapishianas on the Southern savannah. The Makushi Indians have long been known as the makers of the deadly Urari arrow poison, which is prepared from a vine, *Strychnos*

toxifera Schomb., which is found in the forests of the Kanuku mountains. (*See* Schomburgk.) The Wapishiana Indians, being more progressive, are rapidly taking to ranching. Their physique is excellent and far superior to that of the neighbouring tribes. Hammock making has for long been their chief industry. The cotton for this purpose is spun from the raw lint, by the women, into a strong thread. The hammock is worked on a frame, and thus after many weeks labour, an excellent article is produced which can be bought for the equivalent of $4.00.

The staple food of the Indians, in fact of everybody living in this country, is supplied by the cassava plant. After the roots have been grated and the poisonous juice squeezed out, the dry pulp is pounded and baked on a large iron pan, forming a solid disc of cassava bread. In Brazil, and with certain Indian tribes, the cassava is eaten in the form of farine, which is a kind of granular flour, roasted in an open pan. Cassava thus prepared and dry meat—tasso—with the addition of black coffee, in many places are the only foods obtainable. Game is, on the whole, scarce, but excellent fish abound in the creeks in endless variety.

The more enterprising ranchers install a wind pump and irrigate their garden. A variety of luxuries can then be grown such as oranges, limes, sugar apples, soursops and vegetables. Old cattle corrals many of which, surround each ranch, provide excellent soi . In some nearby patch of bush a provision field can be cleared and here corn, upland rice, cotton, tobacco, sweet potato, yams, pineapples, tomatoes, water-melons, pumpkins, bananas, cane and tannias, may all be planted successfully. An onion bed by the waterside is a feature of every ranch.

The list of livestock raised is no less varied and includes fowls, ducks, Guinea fowls, turkeys, pigs, sheep and goats. Cattle and horse raising, of course, form the main industry of the people.

The quality of the tobacco grown is excellent. The leaves are rolled into a firm rod some three feet long, and tightly bound with cane. After a period of maturing, the roll is sliced and rubbed fine, and can then be used in a cigarette or a pipe. This tobacco may be bought in Boâ Vista at the cost of ½d. an ounce.

Passing on to the fauna of the district the first impression of a naturalist upon arrival on the Rupununi savannah, is the almost complete absence of incigenous herbivorous mammals. Though one may see a vast plain of rich grass stretching to the horizon, supporting to-day thousands of head of cattle, not a single wild herbivore will be in evidence. There are, it is true, deer on the savannah, but these are few and solitary, and are confined to the neighbourhood of bush. The only large mammal seen at all frequently is the Giant Anteater—*Mymecophaga jubata**, known locally as the "Tamanduá bandera." This animal appears to be diurnal in habits, or at least it is frequently encountered during the day, quietly going about its business. The anteater subsists largely upon termites. With its powerful claws it tears open their nests and licks up the insects with its cord-like tongue. Termite nests, varying from small beehive-like objects to tall spires some 15 feet high are common all through the savannah.

The only other mammal likely to be encountered during the day time on the savannah is a wild dog or savannah fox, *Canis cancrivorus*. These foxes are usually solitary, though at times a pair are met with. Their fur is rather greyish, though more sandy individuals are seen at times. While standing motionless out on the open savannah it is surprising how difficult they are to see as they may be easily mistaken for a small beehive termite mound.

The larger carnivores are represented by the Jaguar, *Felis onca*, and the Puma, *Felis concolor*. Since the introduction of cattle, these animals have increased considerably and are considered a dangerous menace to the ranching industry. The Red Tiger, as the Puma is called, though smaller than the former species, and of a much more docile disposition, nevertheless is a serious killer of stock. The "u" in the word Puma, by the way, is correctly pronounced as if it were a double "o." A smaller species of cat encountered on the savannah, in the neighbourhood of the Pakaraima foothills, was the Haka tiger—*Felis jaguarundi*.

The Capivara† — *Hydrochaerus capybara*—or Water Haas, as it was called by the early Dutch colonists, is a semi-aquatic animal, found commonly in small parties in the neighbourhood of rivers and lagoons. This is the largest living rodent in the world. Observation by the writer tends to show that these animals breed during the dry months, one or two young being born to each female. Their call note, when alarmed is a siren like whistle. Upon hearing this the party will take to the water, and remain completely submerged, except for the ears, eyes and nose which form a line at the surface of the water. If danger continues to threaten the animal sinks quietly out of sight. The Capivara has assumed a certain amount of importance lately, owing to the value of its skin, which is particularly suitable for certain purposes such as motor car upholstery. Certainly the animal is abundant enough to warrant commercial exploitation and it is easily killed by harpooning in the water. Moreover, its destruction is encouraged by the ranchers as the

* The names used for the mammals are those used in the Georgetown Museum. The author has not yet had time to consult the literature in order to ascertain the latest nomenclature.

† Attains length of some four to five feet and weighs about 100 lb.

Capivara consumes a lot of sweet grass, which can be ill-spared during the dry months. However, the difficulty, so far as the Rupununi district is concerned, is the transportation of the hides to the coast. Extremely soft leather is made locally.

Two species of Otter, or Water Dog, not yet determined, occur in the rivers. The larger species is the usual one seen in the rivers. The smaller kind was only seen once by a bush stream in the Kanuku mountains.

Birds are extremely abundant in this region. Not only is the number of species represented large but also individuals are numerous. Moreover, many species congregate in large flocks. A full list of birds encountered is appended at the end of this article. Only a few of the more important or more interesting forms can be mentioned in detail.

The largest bird on the savannah is the Jabiru Stork, *Mycteria Americana*, known in British Guiana as "Negro Cop." The plumage is white, but the long neck is naked and black with a red fold at its base. The beak is massive. Large numbers of these birds at times collect by a drying up lagoon, presumably to feed on the stranded fish and frogs. At other times a pair of Jabiru may be seen flying at a great height, when suddenly, the wings cease to beat and the birds glide swiftly downwards, making a loud drumming. *Theristicus caudatus* was also observed to drum in a similar way. Especially during the drier months of the year, the swamps and lagoons are the centres of attraction to the birds. Here large flocks of duck occur. The large Muscovy, *Cairina moschata*, three kinds of Wicisi Duck, *Dendrocygna*, and the Brazilian Teal, *Nettion brasiliensis*, being common. Herons, Egrets, Ibises, Storks, Grebes and Water Fowl are sure to be in evidence. Among the shyer birds that are less easily seen may be mentioned the Night Herons, Boatbills and Rails.

The Aete palm swamps are inhabited by numerous parrots and the smaller macaws. The palm Tanager, *Thraupis melanoptera*, is always much in evidence.

The Meadow Lark, *Sturnella*, and the Quail, *Eupsychortyx sonnini* are characteristic of the dry grass savannah. The little parakeet, *Conurus aeruginosus*, occurs abundantly all through the orchard type of savannah. This bird makes its nest inside a hollowed out termite nest, which are so abundant in the branches of Curatella trees. It lays four white eggs. Another parakeet belonging to the same genus is *Conurus solstitialis*. This species appears to be confined to the country on the edge of the flat savannah, at the foot of the Pakaraima foothills. Few more beautiful sights can be imagined than a large flock of these yellow and flame coloured birds, passing by on their way to roost in the hills.

The songsters on the savannah are the Mocking Bird, *Mimus gilvus*, and the Troupial, *Icterus croconotus*. The song of the former reminds one of a rather faint song thrush. That of the Troupial, has won for it the local name of Rouxinoe (nightingale).

The "Sarou," *Heleodytes griseus*, is one of the most interesting birds. It is common all through the orchard type of savannah, and is usually particularly abundant around the houses. Though it belongs to the Wren family, it hardly reminds one of a Wren. Its amusing ways and constant chattering are more reminiscent of a Starling. The Sarou seems to be perpetually occupied in building a nest even though, judging by the complete absence of any eggs, the breeding season is not in progress. The nests which are bulky affairs of dry grass and roots are found in colonies of considerable size. The diet of these birds is probably varied, individuals have been noted eating lizards, while the contents of one stomach examined was composed of insect remains and a few seeds.

The river fringes, which are largely and typically composed of *Inga* sp., support a large bird fauna also. Here the ungainly Hoatzin, *Opisthocomus hoazin*, may be seen in parties of as many as sixty. They flop from branch to branch in an unsteady way, balancing themselves with their wings and tail while all the time they utter a hoarse hissing cry. It was found that in the absences of their well-known food plant, *Montrichardia*, the young shoots of *Inga* formed the bulk of their diet.

The hanaqua, *Ortalis motmot*, a little Guan, though seldom seen, occurs abundantly in the river fringes. Exactly at the crack of dawn the whole countryside resounds with the calls of this bird. It is from this call that the bird has got its popular name "hanaqua." Five minutes after the sun has risen above the horizon, all is again silent and the bird will not be noticed again till sunset, when a somewhat lesser concert may be started.

The sandbanks exposed by the falling rivers, support a special bird fauna as well. It is here that the Skimmer, *Rhyncops nigra*, the various river terns, and the little plover, *Aegialitis collaris*, may be found nesting. The Darter or Snake Bird, *Plotus anhinga*, the Cormorant, *Phalacrocorax vigua*, and the Osprey, *Pandion carolinensis*, are dependent on the river itself.

The enormous bird fauna of the rain forest of the Kanuku mountains cannot be touched upon. It might, however, be mentioned that the Cock-of-the-Rock, *Rupicola rupicola*, perhaps the most beautiful living bird, is abundant in this range.

It is not possible to stay in the Rupununi district without being struck by the vast assemblage of fishes to be found in the savannah rivers, but as these were not studied closely nothing that is not already well known concerning them, was noted.

APPENDIX

Birds seen on the Rupununi Savannah, British Guiana. The list is compiled from field observations and is in no way a complete list of the birds occurring in the district. The season during which these observations were made was the dry season (August-January). The nomenclature employed is based on Snethlage's catalogue of the birds of the Amazon (1). The letters after the name of each bird indicates. the particular habitat of the species, viz.: S=Savannah. R.F.=River fringe. R=River Sw.=Swamp. F=Forest and large bush island.

	CRACIDAE.	
Crax alector L.	F.	
Ortalis motmot (L.)	R.F.	Common.
	ODONTOPHORIDAE.	
Eupsychortyx sonnini (Temm.)	S.	Common.
Odontophorus guianensis (Gm.)	F.	
	COLUMBIDAE.	
Columba rufina Temm.	S. & R.F.	Congregate to feed on fruit of *Curatella americana.*
Zenaida iessieae Ridg.	S.	Very abundant in parties, damaging rice. Nesting Sept.-Oct.
Columbigallina passerina Spix.	S.	Common.
C. talpacoti (Temm. & Knip.)	S.	
Geotrygon montana (L.)	S.	
Leptoptila verreauxi Bp.	S. & R.F.	Common.
	OPISTHOCOMIDAE.	
Opisthocomus hoazin (Müll.)	R.F.	Locally common.
	PODICIPEDIDAE.	
Podilymbus podiceps (L.)	Sw.	On lagoons.
Colymbus dominicus brachyrhynchus		
	LARIDAE.	
Phaetusa magnirostris (Licht.)	R.	Common, congregating to nest on sand banks, December.
Sterna superciliaris Vieill.	R.	Common.
Rhyncops nigra cinerascens Spix.	R.	Nesting on sand banks, December.
	JACANIDAE.	
Parra jacana (L.)	Sw.	Common.
	CHARADRIIDAE.	
Oedicnemus bistriatus (Wagl.)	S.	Common.
Gallinago sp.	Sw.	
Hoploxypterus cayanus (Lath.)	R.	Common and nesting.
Belonopterus cayennensis (Gm.)	S.	Common.
Aegialitis collaris (Vieill.)	R.	
Pisobia Sp.	R.	Common.
	EURYPYGIDAE.	
Eurypyga helias (Pall.)	R.	
	IBIDIDAE.	
Theristicus caudatus (Bodd.)	S.	Common, in parties round lagoons.
Harpiprion cayennensis (Gm.)	R.	Common.
Cercibis oxycerca (Spix.)	S.	Not very common.
	CICONIIDAE.	
Tantalus loculator L.	S.	Common.
Euxenura maguari (Gm.)	S.	
Jabiru mycteria (L.)	S.	Common.
	PLATALEIDAE.	
Ajaia ajaia (L.)	R.	
	ARDEIDAE.	
Butorides striata (L.)	R. & Sw.	Not very common.
Ardea cocoi L.	R. & Sw.	Common.
Herodias egretta (Wils.)	R. & Sw.	Common.
Nycticorax nycticorax	R.	
Florida caerulea (L.)	Sw.	Not common.
Cancroma cochlearius L.	R. & Sw.	Common, roosting in parties during day.
	ANATIDAE.	
Cairina moschata (L.)	S.	Common on lagoons.
Dendrocygna discolor, Sch. & Salv.	S.	Large flocks on the lagoons.
D. bicolor (Vieill.)	S.	
Nettion brasiliense (Gm.)	Sw.	
Alopochen jubatus (Spix.)	R.	

PHALACROCORACIDAE.		
Phalacrocorax vigua (Vieill.)	R.	Common.
PLOTIDAE.		
Plotus anhinga (L.)	R.	Common.
CATHARTIDAE.		
Gypagus papa (L.)	S.	Rare, usually near mountains and forest.
Cathartes aura	S.	Common.
C. urubitinga Peltz.	S.	Only definitely determined once.
Catharista atrata	S.	Very common, but does not extend far beyond cattle country.
ACCIPITRIDAE.		
Heterospizias meridionalis (Lath.)	S.	Common.
Rupornis magnirostris (Gm.)	S.	
Urubutinga urubitinga (Gm.)	S.	
Tachytriorchis albicaudatus (Vieill.)	S.	Common soaring over savannah fires.
Falco sparverius	S.	Common.
Ibycter ater	S. & F.	Not abundant.
Milvago chimachima (Vieill.)	S.	Common.
Polyborus cheriway	S.	Common.
Pandion haliaetus carolinensis	R.	Common.
STRIGIDAE.		
Glaucidium phalaenoides	S. & R.F.	
Speotyto cunicularia	S.	Common in pairs, one on watch, other in the burrow.
Pulsatrix perspicillata (Lath.)		
PSITTACIDAE.		
Ara chloroptera Gray	F.	Common.
A. ararauna (L.)	F.	A party of over fifty seen on one occasion.
A. hahni (Souance)	Sw.	Among Aete palms.
A. manilata (L.)	Sw.	Among Aete palms.
A. macavuana	S.	Parties would visit the savannah streams to drink.
Conurus aeruginosus (L.)	S.	The commonest parakeet on the savannah.
C. soltitialis (L.)	S.	Only seen near mountains.
Amazona amazonica (L.)	F.	Pass over the savannah.
A. farinosa (Bodd.)	F.	Pass over the savannah.
Psittacula guianensis	R.F.	Seen in little parties.
ALCEDINIDAE.		
Ceryle americana (Gm.)	R.	Common.
C. amazona (Lath.)	R.	Common.
C. torquata (L.)	R.	Nesting holes seen in colonies in suitable sandy banks.
C. aenea (Pall.)	R.	Less common.
CAPRIMULGIDAE.		
Caprimulgus maculicaudus Lawr.		

The several other species of nightjars though common were not determined with certainty.

MICROPODIDAE.		
Chaetura zonaris (Shaw.)	S.	At times in flocks of great size.
Reinarda squamata (Cass.)	S.	Common near Aete palms.
TROCHILIDAE.		
Chlorestes notatus (Reich.)	S.	Feeding at flowers of Genipa sp.
CUCULIDAE.		
Piaya cayana (L.)	R.F.	
Crotophaga ani L.	S.	Common.
C. major Gm.	R.F.	Common.
RAMPHASTIDAE.		
Ramphastus toco Müll.	F.	

Other species not determined with certainty.

BUCCONIDAE.		
Chelidoptera tenebrosa (Pall.)	F.	Commonly seen right at the top of tall trees.
GALBULIDAE.		
Galbula galbula (L.)	F.	Common.
Brachygalbula albigularis (Spix)	F.	

PICIDAE.

Ceophloeus lineatus (L.)	F. & R.F.	
Celeus reichenbachi Hell.	F.	

FORMICARIDAE.

Poecilurus kollari	R.F.	Common.
Formicivora grisea (Bodd.)	R.F.	
Myrmeciza longipes (Swains.)	F.	

The numerous other species were not determined.

FUNARIDAE.

Furnarius leucopus Swains.	R.F.	Common along waterside.

TYRANNIDAE.

Tyrannus melancholicus Vieill.		The commonest bird everywhere.
Pitangus lictor (Licht.)	R.F.	Common.
P. sulphuratus (L.)	S. & R.F.	Common.
Arundinicola leucocephala (L.)	S.	Common around swamps.
Pyrocephalus rubineus (Bodd.)	S.	Common around swamps.
Fluvicola pica (Bodd.)	S. & R.F.	Common, swamps and river.
Muscivora tyrannus (L.)	S.	Common.
Megarhynchus pitangua (L.)	R.F.	Common.
Capsiempsis fl. flaveola Licht.		

COTINGIDAE.

Lathria cinerea (Vieill.)	F.	Locally abundant.
Rupicola rupicola (L.)	F.	Kanuku Mts.
Tityra cayana (L.)	F.	

HIRUNDINIDAE.

Atticora melanoleuca (Wied.)	R.	Common.
Tachycineta albiventer (Wied.)	R.	Common.
Stelgidopteryx ruficollis (Vieill.)	R.	Common.
Progne tapera (L.)	R. F. & S.	
Hirundo erythrogastra Bodd.	S.	

TROGLODYTIDAE.

Heleodytes griseus	S.	Common.

MOTACILLIDAE.

Anthus lutescens	S.	Common.

PARIDAE.

Polioptila livida (Gm.)	R.F.	

MIMIDAE.

Mimus gilvus	S.	Common, nesting January.

TURDIDAE.

Planesticus gymnopthalmus Cab.	R.F.	

FRINGILLIDAE.

Paroaria gularis (L.)	R.F.	Common.

The numerous other finches are not dealt with.

COEREBIDAE.

Coereba chloropyga (Cab.)	R.F.	

TANAGRIDAE.

Thraupis episcopus L.	S.	Common.
Th. melanoptera Scl.	S.	Common, in Aete palm swamps.
Ramphocoelus magnirostris Lafr.	F.	Common.

ICTERIDAE.

Icterus chrysocephalus (L.)	S.	
I. xanthornus (Gm.)	S. & R.F.	Common.
Sturnella ludoviciana	S.	Common.
Leistes militaris (L.)	S.	Common.
Xanthornus decumanus Pall.	F.	
Cacicus cela (L.)	S.	Nesting colonies near houses.
Agelaius icterocephalus (L.)	S.	About swamps.

THE GREAT SAVANNAH DISTRICT OF BRITISH GUIANA.

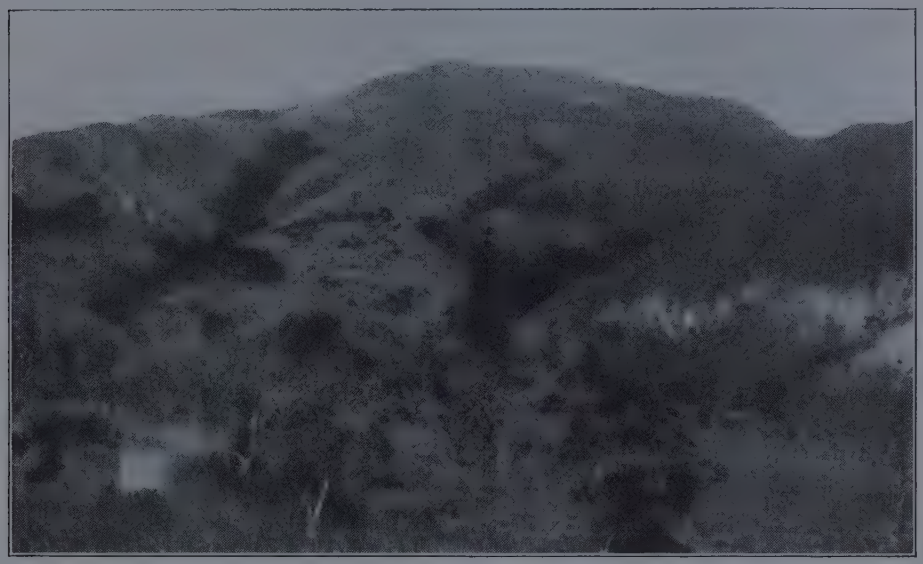


FIG. 1.—*View in the Pakaraima Foot Hills. Trees of "Curatella americana" in the foreground.*

FIG. 2.—*Serekong Village. Showing typical round house. Pakaraima Mountains.*

THE GREAT SAVANNAH DISTRICT OF BRITISH GUIANA.

FIG. 3.—*Savannah vegetation, dry season, showing extent of uncovered ground. The grass "Trachypogon plumosus" recovering from burning. Plants of "Brysonima verbascifolia" in left foreground. A "beehive" termite mound in the centre foreground.*

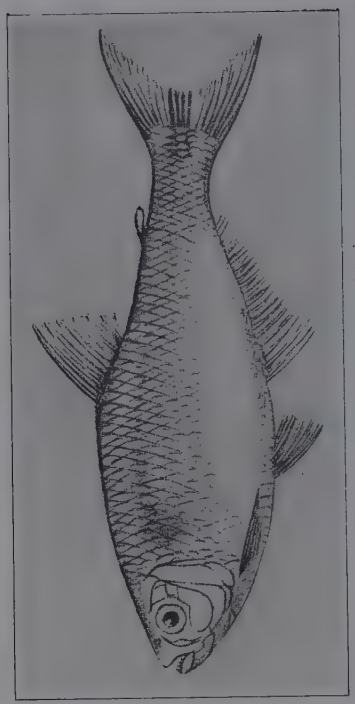
FIG. 4.—*Pakaraima Foot Hills showing "Ant" mounds with non-savannah vegetation appearing on them.*

THE GREAT SAVANNAH DISTRICT OF BRITISH GUIANA.

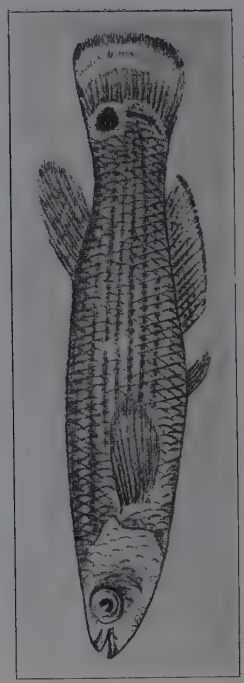
FIG. 5.—*Typical savannah vegetation. Tall Tree: "Frangipani Plumeria." Small Tree: "Byrsonima crassifolia" and the grass "Trachypogon plumosus" in tufts in the foreground. Rupununi Savannah.*

FIG. 6.—*"Church Spire" termite mound, about 10 ft. high. Rupununi Savannah.*

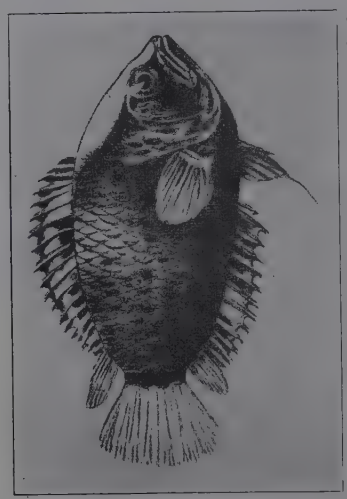
TRINIDAD LARVICIDAL FISHES.



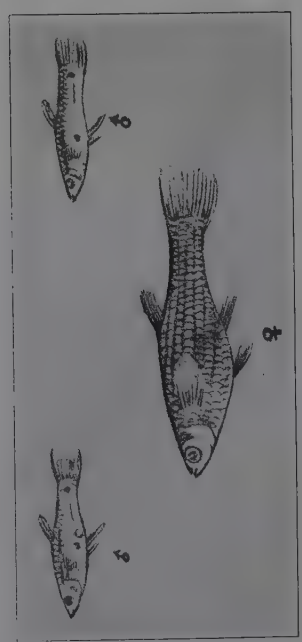
Tetragonopterus guppyi.



Haplochilus harti (Blgr.). 'Small Gaubin'. (*Natural size.*)



Polycentrus schomburghii. 'King or Black Coscorob.' (*Natural size.*)



Lebistes reticulatus. 'Millions.'

By courtesy of the West India Committee.

OBSERVATIONS ON TRINIDAD LARVICIDAL FISHES.

By P. L. Guppy.

Introduction.

The following paper has been written with the object of recording the species of fishes found to be most active in keeping ponds, dams, water holes, drains and reservoirs free from mosquito larvae and of indicating their sphere of utility in the Colony.

The first list (1) of freshwater fishes of Trinidad was published by Dr. Theodore Gill in 1858, 23 species being described. One of these, *Corynopoma riisii*, received no less than three generic and four specific names. In 1906, Regan published a paper (2) in which 41 species are recorded.

The following six species have been added since:—

Poecilia vivipara, Regan.
Eleotris pisonis, Gmelin.
Gobius soporator, Cuv. and Val.
Caecorhamdia urichi, Norman, n.sp. "Blind Catfish."
**Pristella riddlei*, Meek.
Charax gibbosa, Linn.

There are two Mulets, *Agonostomus percoides* and *A. microps*, which are "said to occur in Trinidad or neighbouring islands" (Dr. C. Tate Regan)—not yet confirmed, from Trinidad. *A. monticola* is well known in Trinidad, very abundant in Tobago and throughout the West Indies. In this species (*A. monticola*) the cleft of the mouth extends to, or a little beyond the vertical from the anterior edge of the eye. The others (*microps* and *percoides*†) differ in that in the adult the cleft of the mouth extends to below the middle of the eye.

Two papers by Fowler, dated respectively 1915 and 1931, contain lists of Trinidad fishes with descriptions of new species and figures. In the former (3), Regan's paper is referred to as "a very interesting and valuable account" but states that "while likely most of the fresh water species have been discovered further collecting of the marine forms will undoubtedly yield many others". In the latter (4) the author describes specimens collected by L. Wehekind of Trinidad. Among these are species taken in reservoirs at Brighton and at La Brea, which are of interest in connection with further observations made by the writer.

Fish Habitats.

(*a*) *Artificial Waters.*

Most of the reservoirs are situated in the southern part of the island where it has been necessary, on account of shortage of natural sources of water supply to construct large dams for collecting and conserving water. These reservoirs are sometimes surrounded by forest vegetation. They are generally well stocked with several species of larvicidal fishes. The fish-life here is mainly confined to the edges of the dams where the thick rank grasses extend their growth into the shallow waters. In such surroundings large numbers of fish may be caught with a muslin bag net, mostly "Millions" (*Lebistes*) and "Small Coscorob" (*Acara pulchra*), also the larger "Coscorob" (*Cichlosoma bimaculatum*). The large "Guabin" (*Hoplias malabaricus*) was hooked several times. Three species of "Sardines" (*Characinidae*) were taken in neighbouring drains and water holes and it is suspected that these occur in all the larger reservoirs. Fowler records seven species as occurring in reservoirs in and around Brighton, La Brea, collected by L. Wehekind in 1930. These are also found at Palo Seco and Erin, and are of course well distributed throughout the island. The Palo Seco and Erin *Lebistes* are a small variety with small broods, well equipped for moving about among the grassy borders of artificial waters.

None of the reservoirs appear to have been artificially stocked with fish. *Lebistes* and *Rivulus harti* may have been introduced in some localities in this manner although it is doubtful whether "Sardines," "Coscorobs" and others were. Fishes and mosquitoes are extensively distributed to drains, basins, dams, &c., during rainy weather by flood water—in fact, to any localities where conditions are favourable. Natural processes of colonization may be very tardy in the case of the fish, but not so with adult mosquitoes which can fly and may become established ahead of the former. Thus, it is doubtful whether all the useful species of fishes reach artificial waters in all localities. Colonization should not therefore be left to chance; the introduction of fishes to such waters might be systematically organized and the requirements in this respect ascertained in all recently erected reservoirs, aqueducts, &c.

(*b*) *Ponds and Water Holes.*

Little is known of the fish fauna of the numerous ponds and water holes found mainly on sugar estates in the southern districts of the island. The subject might be studied with a view to recording the species and ascertaining the incidence of ichthyophthiriasis, a fish disease which occurs during the dry season through conditions arising from the absence of running water. The writer's investigations in this respect have been limited to the Northern Hills and environs, except recently at Palo Seco, Debe, Penal and Siparia during "Indian Summer" conditions (*i.e.*, October). In these localities water holes exist everywhere and those occurring in the vicinity of rice fields are sometimes connected to small streams. No information is available as to whether such water holes

* *Pristella riddlei*. Recorded by Fowler. *Proc. Acad. Nat. Sciences*, Vol. LXXXIII, 1931. First recorded by L. Wehekind. Abundant Botanic Gardens Trench, British Guiana. Eigenmann, Fresh Water Fishes of British Guiana.

† *Percoides* is probably the same as *monticola*. *See* the Fishes of Port-au-Prince Bay, Hayti. By William Beebe, sc.d. and John Tee-Van. Dec., 1928.

are permanently full of water or get only filled by flood water during the wet season. Fishes were, however, always present and the following species were recorded :—*Kivulus harti* (not abundant), *Corynopoma riisii*, *Lebistes reticulatus* and *Odontostilbe pulcher** (occasional). "Cascadura" (*Callichthys-Corydoras*) were plentiful in the rice fields where they are much sought after during the dry spells when they are easier to catch. At the time when the records were made there were no traces of mosquito larvae in the grassy edges round the water holes.

(*c*) *Rice Fields.*

The fish fauna in rice fields is quite varied and several species have been found in the main drains surrounding the fields, where ample food is available and occasionally also in puddles in growing rice. Where rice fields are situated in the neighbourhood of streams or overflows from water courses the distribution of fishes might be helped by the provision of drains which would ensure the constant presence of running water. Steps should also be taken to prevent too much puddling of the land.

(*d*) *Estuarine and Sea Coast Conditions.*

This heading includes tidal mangrove swamps which are subject to temporary flooding by sea and rain. The movements of fishes are generally hampered in this environment by the excessive amount of débris which usually accumulates in between mangrove roots and in situations where the mud hardly ever dries off completely. These conditions can be remedied by the opening of drains which will help the fish to circulate freely.

In Laventille, dirty grass-grown drains subject to tidal influence, with very foul black mud, were found to contain *Poecilia vivipara* and *Kivulus harti* (abundant). Fishes are very partial to such drains which should always be kept open.

One swampy grass area was observed which proved rich in "Millions" and *Kivulus harti*.

On the north bank of the Pilot River, Guayaguayare, the system of drainage evolved permits of the distribution of the waters of the incoming tide through the coconut groves. Isolated pools have been found in these drains, before the tide rises, well stocked with *Poecilia vivipara* which are joined by schools of other species borne on incoming waters. It is probable that marine forms of immature fishes are similarly distributed.

Where swampy areas are being drained by sluice gates as at Buccoo Bay, Tobago, it was found that in the main drain which led to the sea and which conveyed some fresh water from the Buccoo stream, large numbers of *Poecilia vivipara* and *Lebistes* occurred. There were also some *R. harti* but *Poecilia* greatly predominated.

Grassy drains examined at Claxton's Bay, Trinidad, which were parallel to a main road and had a swamp on one side contained large quantities of *R. harti*. The water was only a few inches deep and the drains very narrow. No *vivipara* were present although this species may generally be looked for in these swampy areas.

In small tidal pools cut off from the sea small Tarpon (*Tarpon atlanticus**) may frequently be caught with a cast net. Tarpon seem to spend the early stages of their existence feeding on small fry, prawns and allied crustaceans. The fresh and brackish water fishes of the Colony appear to be important and might be further investigated.

Restocking.

Most artificial waters are populated with larvicidal fishes although it is not known to what extent the beneficial species occur. When these have died down, either through natural or artificial causes, steps should be taken to replace them. Both in rice fields and in environments which are of difficult access to fishes (*e.g.*, mangrove swamps) suitable drainage systems might be devised to allow for their free movement. For colonization purposes species should be selected according to their particular habits. In this respect some fishes are essentially scavengers while others are insect feeders. Of these, again, some prefer the deep to the shallow waters. Certain species of sardines, for example, which confine their activities to clear mountain streams could be introduced advantageously in reservoirs used for storing drinking water. Again, in any scheme of land reclamation species which propagate rapidly should be used, such as *Poecilia vivipara*. The question of the transport of fishes from one area to another offers no difficulty. For this purpose special containers holding two gallons of water should be used in which 50 to 100 fishes (1 in. to 2 ins. long), may be moved any required distance by road or rail.

Summary.

This paper includes a brief review of some of the literature published on Trinidad fishes and a description of various localities where certain species have been known to occur and suggests certain methods by which the beneficial species might be propagated. Below will be found an appendix containing detailed notes of some of the principal larvicidal species together with a list of such species.

References.

(1) *Ann. Lyc.*, New York, VI, pp. 363-430.

(2) "The Fresh Water Fishes of the Island of Trinidad, based on the Collection, Notes and Sketches made by Mr. Lechmere Guppy, Jnr." By C. Tate Regan. *Proceeds. of Zoo. Soc.*, London, Vol. I.

(3) "The Fishes of Trinidad, Grenada, &c." By H. W. Fowler. *Proc. Acad. Nat. Sciences*, Philadelphia, Vol. LXVII, 1915, pp. 520-543.

(4) Fishes obtained by the Barber Asphalt Company in Trinidad and Venezuela in 1930. *Proc. Acad. Nat. Sciences*, Philadelphia, Vol. LXXXIII, 1931.

* *Chirodon pulcher* (Syn.).

* *Centropomidae & Mugilidae* species.

APPENDIX.

I.—Notes on Larvicidal Fishes.

HABITS OF SOME SPECIES UNDER FIELD AND AQUARIUM CONDITIONS.

Family : POECILIIDAE, "Live bearers." "Millions."

Includes two species of viviparous fishes of which females are larger than males and otherwise differ. Anal fin of male developed into an intromittent organ. Distal segments of prolonged rays may be variously modified into spines, hooks, barbs, &c., which may help to retain the organ in position during coition. Differences in structure of this organ are of great systematic importance. Young, well developed at birth, from 5 to 10 mm. Adult males often less than an inch in length. Females, 1½ to 2¼ ins. Bulky ripe females look twice the size of the former.

Two genera recorded for Trinidad, one species in each :—

(1) *Lebistes reticulatus*, Peters.
(*Girardinus gup yi*, Gunth.)
"Rainbow-fish," "Guppy-fish," "Belly-fish."

In male, dorsal more elevated than female and when laid back nearly reaches base of caudal fin. Pelvics nearly as long as short intromittent organ. Colouration very variable, metallic or iridescent rainbow hues, with two, three or more black spots. Sometimes longitudinal line. Dorsal and caudal often marked or coloured, or plainly translucent. Some specimens with remarkable colour combinations. For aquarium lovers specialized breeding has evolved novelties in colour schemes.

Fecundity of females differs greatly. A small variety obtained in dams at Palo Seco of which several were dissected contained three, nine and up to seventeen well developed and lively young, almost ready for extrusion. Similar species found at Erin Dam. In both localities very numerous sexes found in equal numbers. Not quite ripe females contained yellow yoke-like mass. According to Norman* the number of young produced by this species at each birth depends on the age of the mother. It may be as high as 50 or even 70. "A phenomenon well-known to fanciers who keep "Cyprinodonts in aquaria is that a female whose "male has been removed can give birth to several "broods of young without further copulation. This "also applies in a high degree to *Lebistes reticulatus*. "A female kept isolated from its arrival at this "laboratory thus gave birth, in the course of about "half a year, to no less than seven broods of young "at regular intervals. The ova in question must "thus have been fertilized by stored spermatozoa "which had remained living in the female for up to "half a year. . . ."

The largest females—1¾ ins.—collected by the author, contained from 40 to 41 well developed young, or bunches of grape-like golden yellow ova corresponding to these numbers and representing subsequent broods. The whole of one brood appears to be extruded in a few hours on the same day. Results obtained in the case of laboratory bred fishes regarding proportion of sexes agree with field conditions, *i.e.*, sexes herd together and are found in equal numbers ; this may be observed in the dams where undersized females seem largely to be in evidence. Found in grassy drains at Streatham Lodge, Tunapuna, where the stems and roots of the "Water-grass" (*Commelina virginica*) are thickly interwoven in the water.

(2) *Poecilia vivipara*, Schneid.
(*Poecilia unimaculata*, Val.)
"Brackish-water Millions."

Female olivaceous ; edges of scales usually darker ; body often with dark cross-bars and a blackish spot which may be pale-edged on upper part of side, in front of dorsal fin. Sometimes a pair of blackish spots at base of caudal (tail). Fins occasionally without spots. In size and appearance bears considerable resemblance to female *Lebistes*. Often slightly larger, about 2 ins. in length. Males smaller. Markings and colour of Trinidad specimens elegant and remarkably consistent, a dark ocellated spot always present in both sexes, and, in addition, males may readily be distinguished by lateral cross-bars, sometimes obscure, and, in the case of Tobago specimens, with electric blue iridescence. Dorsal and caudal decorated in adult males with black and red margins with some yellow. There is little of the gaudy rainbow colour schemes about these males which are such a feature of *Lebistes*. Very active species, much more so than *Lebistes*. Take fright easily and become panicky, dashing off in all directions when alarmed. Gregarious like *Lebistes*.

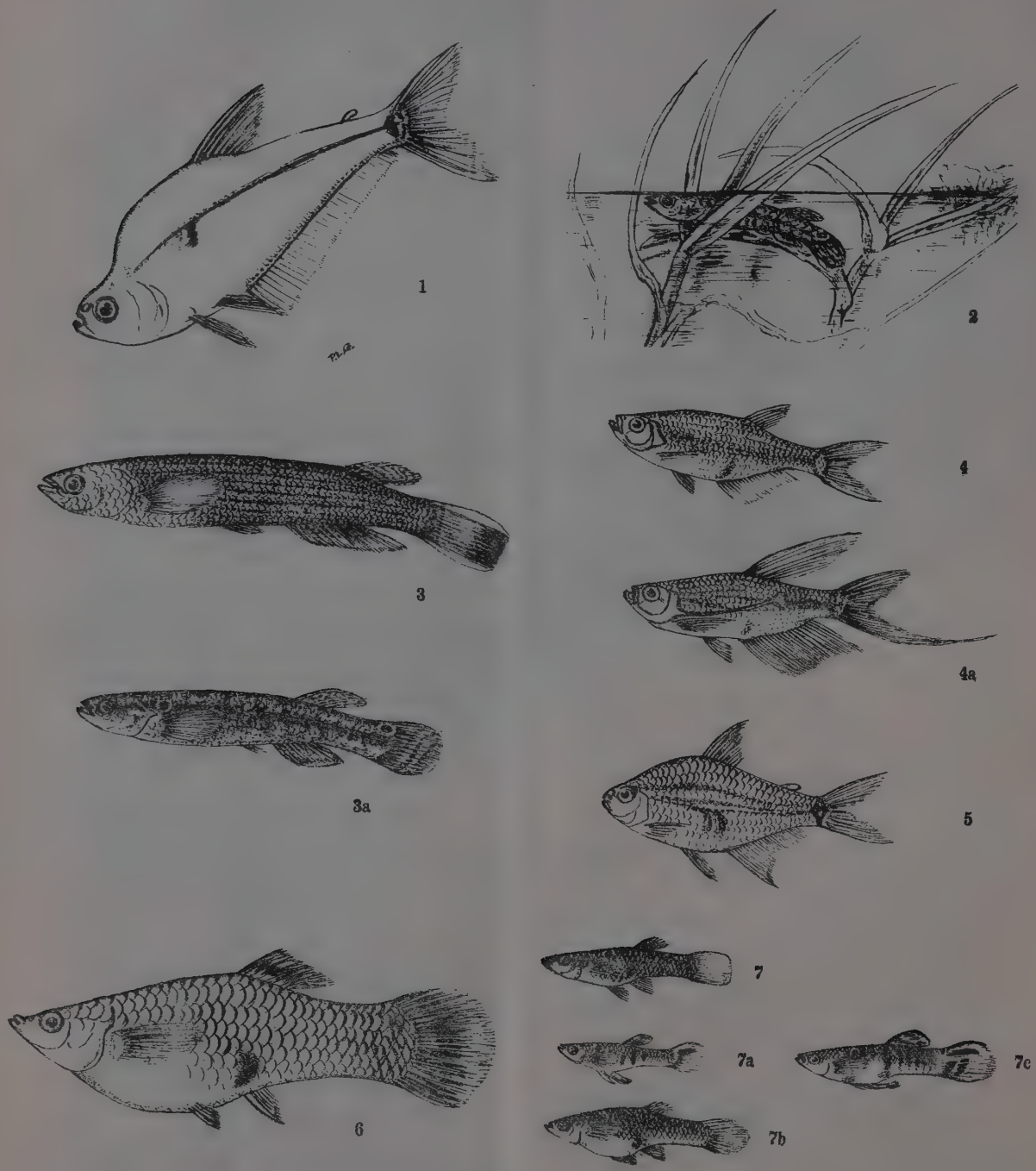
In certain localities near the sea, such as coconut estate drains, where food is abundant in the form of shrimps, water-insects, &c., fishes of this species are remarkably well developed and grow to a length of 2¾ to 3 ins. (both sexes). Schools of large-sized females cruise about together at certain seasons, some of which contain 100 to 140 young ready for extrusion. In these well grown examples, sexes bear a close resemblance to one another, whereas in those of the commoner sizes met with, ¾ to 1¼ ins., the superficial difference is striking—the males being very prettily marked. The conspicuous black spot on side with silver ring is present in both sexes. On further development this disappears and they become uniformly pearly grey, with black and yellow in dorsal ; caudal with black extending along upper and lower margins of fin. Species varies greatly at different stages of growth. Occasionally specimens have salmon pink or golden yellow undersides. This is, of course, confined to males, and rather exceptional. This touch of colour, added to the usual metallic blue-bronze sheen on body, makes this variety a most attractive looking fish. Black transverse bars are more constant in males than in females : these markings are conspicuous in specimens from certain localities and, of course, vary with age, &c. Sexual maturity reached in about three months. Broods produced at this age are small, but the number in each gradually increases with development until over 100 in each brood is attained.

AQUARIUM OBSERVATIONS ON *Lebistes* AND *P. vivipara*.

Two dozen specimens of both species with equal numbers of sexes were observed. Soon became quite accustomed to confinement. Aquaria planted with water-grass to represent environment from which specimens were collected, with, of course, different species of snails found in their habitat. Fishes generally are busy searching among the grass for anything edible, biting at fine hair roots of grass, often nibbling at snail's antennae when these are

* Norman, J. R. — "Racial Investigations," Part IV. *Johs. Schmidt*, Vol. XIV, No. 8. Reports of Carlsberg Laboratory, 1920.

LARVICIDAL FISHES.



DESCRIPTION OF PLATE.

(*See list page* .)

1. CHARAX GIBBOSA. Linn.
2. RIVULUS HARTI. Blgr. Lying among grass.
3. 3A. RIVULUS HARTI. Blgr. Two varieties.
4. CORYNOPOMA RIISII. Gill. Female.
4A. CORYNOPOMA RIISII. Gill. Male.
5. CHIRODON PULCHER. Gill.
6. POECILIA VIVIPARA. Schneider. Female.
7. 7B. POECILIA VIVIPARA. Schneider. 3 to 4 months. Female.
7A. & 7C. POECILIA VIVIPARA. Males.

moving about. Appear omnivorous. Feed on earthworms, fresh meat cut fine, toast and dry biscuit. Exceptionally partial to mosquito larvae. *P. vivipara* observed to take recently hatched larvae 2¼ hours after extrusion. Adults of this species make good scavengers, consume dead bodies of their own species and any other after putrefaction has set in, remains of earthworms, &c. Change from original water habitat to clean water does not affect fish adversely provided the water used is old, *i.e.*, stored for some time in vessel with grass and mud.

Family : CYPRINODONTIDAE.

Rivulus (*Haplochilus*) *harti*. Blgr.

EGG-LAYING KILLYFISHES.

Known as small "Guabin" or "Leaping Fish" from its habit of jumping out of vessels in which it is placed. Found everywhere in Trinidad and Tobago. Occurs at considerable elevations. Fishes of this species may be the sole occupants of mountain pools and streams. Will travel overland in wet weather by a series of rapid leaps, reaching by this means otherwise inaccessible spots. Very active and voracious, inclined to be solitary and secretive in habits, concealing themselves among grass, débris or any floating object, mostly keeping near the surface and snapping up small fry that may approach them. In aquarium, attack other fishes and must, therefore, be kept to themselves. Will often leave the water and adhere to the glass for long periods*, sticking on by means of their oval shaped tails, in any position, head down or otherwise. Grow to a length of 3¾ ins. under favourable conditions, being, however, more often under 3 ins. Partial to drains and small pools with dirty water, often taken with *Lebistes* and *Poecilia*, but only a few at a time as they are not gregarious.

Unlike the Poeciliidae, there is no marked external indication of sex. Considerable variation, however, in colour and markings at different stages of growth. Ocellus, or eye-like spot, at base of caudal (tail) often absent. Specimen in aquarium (author's) about 2½ ins. in length, with no black caudal ocellus. Colour, pale to silvery blue with darker shades dorsally. Caudal (tail) blue-black, with a white margin above and below. Side of body greenish with seven rows of longitudinal reddish spots. Side of face electric blue. In contrast to this colour scheme aquarium specimens also with two ocelli, one humeral, and the other, as is often the case, on tail. These are smaller, just under 2 ins., with no trace of blue or green, or lines of spots, changing from pale mottled, to dark blackish-grey patterns radiating laterally, with whitish spots. Very small specimens less than an inch have faint marks on their pale translucent bodies with greenish reflections, and a distinct black ocellus on base of tail. *Rivulus harti* is Barracouta-like in attacking its prey. It never exceeds 4 ins. in length. Numbers hooked about this size in a deep mountain pool with pin and worm bait. Voracity so great as to lead to fighting in water to be first on the hook.

* *Rivulus* spp.—Method of ascent of vertical walls : clinging by adhesion of tail and getting higher and higher by this means. Fresh Water Fishes—British Guiana, 1910. EIGENMANN.

Family : CHARACINIDAE.

Genera :—*Tetragonopterus* (*Astyanax*),
(*Hemigrammus*).
Chirodon (*Odontostilbe*).
Corynopoma (*Stevardia*).
Curimatus.

(Synonyms in brackets.)

These four genera of so-called "Sardines" fairly well distributed in the fresh waters of the Colony. Genus Pristella, *i.e.*, *Pristella riddlei*, appears to be local: collected by L. Wehekind at La Brea and Point Fortin. With exception of *Curimatus argenteus*, the "Sardines" are gregarious, and generally cruise about in small schools. Movements very swift. When feeding, however, a school may be observed with individuals almost motionless except for nervous jerky action of fins. All alert, ready to dash off at any angle to seize anything edible. Very efficient mosquito destroyers, insatiable appetite for larvae. *Tetragonopterus maculatus*, "Pink-finned Sardine," most abundant in Maracas and St. Joseph rivers and similar streams. Other species prefer amber-tinted or muddy water. One or more of these "Sardines" may be found in the dams and artificial waters of the Colony but not *Tetragonopterus guppyi*, which is a mountain stream "Sardine" frequenting only clear water.

Charax gibbosa, Linn.

HUNCHBACK SARDINE, GLASS-FISH.

This is a new record for Trinidad. Found in fair numbers at Sangre Grande and Rio Claro. The nape is bent (Fig. 1), producing the peculiar appearance from which its name is derived, body and tail tilted upwards. This is its normal position, quite unlike the poise of any other fish, except, of course, its congeners. Others of the same genus, resembling this, the prime specific character in which they differ being the number of rays in the long anal fin. Popularly known as "Glass-fish" owing to transparency of body. Voracious feeders and take any kind of food.

Family : NANDIDAE.

Genus :—*Polycentrus* (*Polycentrus schomburgkii*, Mull. and Trosch.).

KING OR BLACK COSCOROB.

Only genus represented in this Colony. Described as follows* :—

"The 'King or Black Coscorob' . . . changes "when alarmed, almost instantly from black to "whitish or pinkish white, rapidly vibrates the "pectoral fins, and instead of swimming away turns "on its side and remains for a long time in a "crouching position. They are uncommon, and were "caught by means of a circular hand net in the thick "rank grass which grows at the sides of the ravines. "(Streatham Lodge Estate.)" Range :—Trinidad, Venezuela, Guiana.

Species since found quite widely distributed in Trinidad. Occurs in Pitch Lake runnels at Brighton, La Brea. In addition to the chameleon-like changes in appearance described above, may also become white-spotted. Specimens taken by L. Wehekind at Pitch Lake, and Capt. Totton of British Museum ("Rodney" Expedition, 1931), from same locality, show this variation.

* *P.Z.S.*, London, 1906, p. 391.

Family : CICHLIDAE. Fresh Water Coscorobs.

Three Genera :—*Acara, Cichlosoma, Crenicichla.*

(1) Acara. *Acara* (*Aequidens*) *pulchra*, Gill, (*pulcher*).

SMALL COSCOROB.

"A very elegant fish, prettily marked with bright "green and blue spots and with dark cross-bars on "sides. One of these beautiful fishes observed in "charge of its family of about 100 young. Small "fry were moving under its body and when any "other fish attempted to snatch one, the offender "was viciously snapped at." Observed in Caura Valley River.

Plentiful and well distributed in the island. Collected by L. Wehekind in swamp, Point Fortin, and water-hole, Cedros. Very partial to mosquito larvae, earthworms, &c. Abundant, rice fields, Streatham Lodge, Tunapuna, drains and water-holes.

Range :—Colombia, Venezuela, Trinidad.

(2) *Cichlosoma bimaculatum*, L.

LARGE COSCOROB.

Somewhat similar to above in form, but not in colour, being blackish or dark brown, with a large black spot on side and another at base of tail. Latter may be divided into two and take the form of transverse bars, one broad, one narrow. Plentiful in muddy rivers, ponds and swamps, but not in the clear streams. Abundant, Erin Dam. Many immature specimens netted in thick, rank grass growing at borders. Grows to a larger size than *A. pulchra*.

Range :—Brazil, Guiana, Venezuela.

(3) *Crenicichla saxatilis*, L.

MULET.

Elongate, pike-like in form. Head, olive or greyish-green. Eye with a dark crimson splash. Back, dull olive and yellowish-green. Belly, greyish or bluish-grey ; pale green metallic spots on the sides often present, or if absent, blackish cross-bars, sometimes a blackish longitudinal stripe. Fins varying from yellowish to blackish blue, sometimes edged with black and white. Found singly or in pairs in most streams and pools and take a hook readily at times. Pugnacious, destroyers of *Lebistes*.

Range :—Rio Grande do Sul to Venezuela.

Family : SILURIDAE and LORICARIIDAE.

CATFISHES, TETAS, CASCADOUX, CASCADURA.

Recent observations* under aquarium conditions indicate that mosquito larvae do not occur in containers where the above are kept. Fishes belonging to these families rummage about in the mud for food but they will readily come to the top for anything edible floating on the surface of the water. It is not possible to say whether they would be efficient in preventing mosquito-breeding under field conditions. Most of the species listed frequent the swampy areas in which these armoured mud-fishes are found. The ordinary "Catfishes" belonging to the genera *Pimelodus* and *Rhamdia* (without armour) are voracious feeders and would be efficient in destroying mosquito larvae.

II.—List of some of the Principal Larvicidal Fishes of the Colony.

(Names in brackets are synonyms.)

	Popular Name.	*Remarks.*
1. † *Lebistes reticulatus*, Peters. (*Girardinus guppyi*, Gunth)	Rainbow-fish, Guppy-fish, Belly-fish, Millions.	Venezuela and several West Indian Islands. Abundant everywhere.
2. *Poecilia vivipara*, Schneid. (*Poecilia unimaculata*, Val.)	Millions	Brackish water usually. Often found with above spp. in drains. Plentiful. Venezuela and Leeward Islands to La Plata.
3. † *Corynopoma riisii*, Gill. (*Stevardia albipinnis*, Gill.)	Swallow-tail Sardine	Recorded only from Trinidad. Plentiful.
4. *Tetragonopterus taeniurus*, Gill. (*Astyanax taeniurus*, Gill.)	Sardine	Recorded only from Trinidad. Mountain streams usually.
5. *Tetragonopterus guppyi*, Regan. (*Astyanax guppyi*, Regan.)	Sardine	Recorded only from Trinidad. Mountain streams.
6. † *Tetragonopterus maculatus*, Regan. (*Astyanax bimaculatus*, Linn.)	Pink-finned Sardine	Abundant in Northern Valley streams, dams, &c. Brazil, Guiana, Venezuela.
7. † *Tetragonopterus unilineatus*, Gill. (*Hemigrammus unilineatus*, Gill.)	Sardine dorée	Recorded only from Trinidad. Abundant.
8. † *Chirodon pulcher*, Gill. (*Odontostilbe pulcher*, Gill.)	Sardine dorée	Recorded only from Trinidad. Plentiful.
9. *Curimatus argenteus*, Gill.	Stout Sardine	Not very abundant. Recorded only from Dominica and Trinidad.
10. † *Haplochilus harti*, Blgr. (*Rivulus harti*, Regan.)	Leaping Guabin	Abundant. Recorded from Trinidad and Venezuela.
11. *Polycentrus schomburgkii*, Mull. & Trosch.	Black Coscorob	Plentiful. Trinidad, Venezuela, Guiana.
12. † *Acara pulchra*, Gill. (*Aequidens pulcher*, Gill.)	Small Coscorob	Plentiful. Trinidad, Venezuela, Colombia.
13. † *Cichl soma bimaculatum*, Linn.	Large Coscorob	Plentiful. Trinidad, Venezuela, Guiana.
14. *Crenicichla saxatilis*, Linn.	Mulet	Not gregarious. Well distributed in Trinidad, Rio Grande do Sul to Venezuela.
15. *Charax gibbosa*, Linn.	Hunch-back Sardine	Fairly plentiful. British Guiana and Colombia.

N.B.—Nos. 1, 10 and 11, found in Pitch Lake runnels, Brighton, La Brea.

* Experiment tried in 10 containers, 4 gallons each. Period 8 months. Number of fish in each container 20 to 100 according to size of specimens ; sizes 1½ to 4 ins. Neither eggs nor larvae found during period from March to October, 1933. Mosquito larvae soon appeared in containers without fish.

† Usually found in dams.

SOME FROGS AND TOADS OF TRINIDAD.

By H. W. Parker.
Dept. of Zoology, British Museum (Natural History).

In a previous number of *Tropical Agriculture* (1) the author gave a list of the 23 kinds of amphibians known to inhabit Trinidad, and also a "Key" for the rapid identification of the species. Since the publication of that list the British Museum has received further material, collected by Mr. D. Vesey-FitzGerald, whose attention was drawn to this group of animals by their usefulness in destroying insects in the cane fields. Thanks to Mr. FitzGerald's efforts a new species can now be added to the fauna, the doubtful status of two others has been cleared up and a foolish slip discovered in the "Key."

FAMILY CERATOPHRYIDAE.

(1) **Leptodactylus typhonius** (Daudin).

This species was included with *L. petersi* in section 22 of the "Key," both being said to have fringes of skin on the toes laterally. Actually no such fringes are present in *L. typhonius*, which consequently will fall into section 21, with *Leptodactylus pentadactylus*. But *L. typhonius* may be readily distinguished by its smaller size, more pointed snout, the six longitudinal folds of skin on its back and the black and yellow (instead of red) marbling of the thighs.

FAMILY HYLIDAE.

(2) **Pseudis paradoxa** (Linn.)

The author previously suggested that the records of this species from Trinidad might be the result of confusion with *Rana palmipes*, but a series of specimens collected at Mayaro puts the matter beyond doubt. Mr. FitzGerald reports that these green aquatic frogs are plentiful in one pond at Mayaro, but that he never encountered the species elsewhere.

(3) **Hyla minuta** Peters.

This species was included as a member of the Trinidad fauna with some doubt. But since a specimen has now been collected on Mt. St. Benedict there can be no doubt that the specimens confused with *Hyla goughi* by E. G. Boulenger were really of Trinidad origin. The species is characterised by a large hour-glass shaped marking on the anterior part of the back with one or two transversely elongate oval blotches behind it. These markings may be somewhat broken up or obscured, and a good idea of the variation is given by the four central figures in Boulenger's coloured plate of "*Hyla goughi*."—(*Proc. Zool. Soc.*, London, 1911, Pl. LXIV.)

(4) **Hyla goughi** E. G. Boulenger.

A male and three females of this species were collected. The colour of the upper surfaces is either uniform cream or pale russet brown; the upper figure of the coloured plate mentioned above appears to be the only specimen really referable to this species and shows the cream type of colouration.

(5) **Gastrotheca fitzgeraldi** sp.n.

Mr. FitzGerald's most interesting discovery was that of a pouched tree-frog collected at about 3,000 ft. on Mt. Tucuche in October. This specimen, now number 1934.2.26.1 in the British Museum, is the type of a new species of the genus *Gastrotheca*, which appears to be closely allied to the Venezuelan *G. pygmaea* (Boettger) but is smaller, carries fewer eggs and is differently coloured. Females of this species can be distinguished at once from any other Trinidad frog by the brood sac on the back in which the eggs are carried, and which opens by a long slit on the mid-line from the level of the arms almost to the vent. Males would fall into section 13 (*a*) of the "Key," but are distinguishable from *Hyla rubra*, which occupies that position, by the fact that there are no yellow spots on the legs, the first finger is much longer than the second and the toes only 1/3 instead of 3/4 webbed. The technical description of the species is as follows :—

Tongue small, round, scarcely free behind. Vomerine teeth in two short, slightly oblique series on a level with the hinder borders of the choanae. Head short and broad, with large, prominent eyes which are as long as the snout. The latter rounded, scarcely prominent, with obtuse canthus rostralis and slightly oblique loreal region; nostril much nearer the tip of the snout than the eye; interorbital space as broad as the upper eyelid; tympanum about 1/3 as wide as the eye. Fingers free, the first much longer than the second, but not extending quite as far as the fourth; discs of the two outer fingers as large as the tympanum, those of the two inner fingers smaller. Toes hardly 1/3 webbed, with slightly smaller discs than the outer fingers; the fifth extending a little beyond the third; subarticular tubercles well developed; an oval inner, and a small, conical, outer, metatarsal tubercle at the base of the fourth metatarsal; a row of three or four prominences along the inner edge of the tarsus. Tibio-tarsal articulation reaching the anterior border of the eye.

Skin smooth, except on the belly and hinder side of the thighs, which are granular; head skin free from the skull.

Ash-grey above; limbs with dark cross bars. A dusky line from the eye above the tympanum to the fore limb; hinder side of thighs uniform brown. Lower surfaces yellowish, the throat faintly brown stippled.

Length from snout to vent 19 mm. Brood-sac opening by a long slit and containing two very large (4 mm.) eggs.

(1) Vol. X, No. 1, 1933, pp. 8-12.

NITROGEN AND PLANT GROWTH.

Some Effects of Varying Temperatures.

It is well recognised that interactions between carbohydrates and nitrogenous substances within the plant are closely connected with the processes of growth and reproduction. Much of the research concerned with these interactions has been done in temperate countries, and the question as to what extent the findings need modification in their application to tropical crops is an important one. A recent paper* by G. T. Nightingale deals with the effects of temperature on the utilisation of carbohydrates and nitrogen in the tomato, and suggests a line of investigation which might well be taken further in the interests of tropical agriculture.

Tomatoes of the variety 'Bonny Best' were propagated from seed and grown in sifted loam to a height of about 8 cms. at which time they were lifted, the roots carefully washed free of adhering loam, and the plants transferred to washed quartz sand in 10-inch clay pots, five to a pot. They were kept in a greenhouse at a day temperature of 70 to 75°F. and a night temperature of 65 to 70°F. and were given daily applications of a nitrogen-free nutrient solution of composition shown in the table.

Composition of nutrient solution, in partial volumes molecular concentration.

	Complete nutrient.	Nitrogen free nutrient.
$Ca(NO_3)_2$	0.0090	—
KH_2PO_4	0.0045	0.0045
$MgSO_4$	0.0045	0.0045
$CaCl_2$	—	0.0090

After about six weeks of N-free treatment the different temperatures were applied; three chambers were used each accommodating 100 plants, with controlled temperatures of 55° F., 70°F. and 95°F. respectively and all three with 85 per cent. relative humidity. Each temperature experiment was divided into two parts, one in which the plants were continued on the N-free nutrient, and the other in which the plants were supplied with nitrogen. All the temperature experiments were harvested after ten days.

A sample taken for analysis from the plants after the initial six weeks of nitrogen free treatment before the constant temperatures were applied, showed typical nitrogen deficiency, *i.e.*, the stems were hard and woody, the root systems were relatively large and ramifying, and starch was abundant in all parenchymatous tissue. The lack of nitrogen was evidently checking the utilisation of carbohydrates in protein synthesis and growth.

It may be explained that for the plant to manufacture proteins, both carbohydrates and nitrogen-containing substances are required. Under conditions of nitrogen starvation protein synthesis is necessarily reduced and must eventually cease*. Hence the carbohydrates formed in photosynthesis by the N-free plants, having no utilisation other than in respiration, would be expected to accumulate in the tissues. A carbohydrate analysis of these plants should thus give an approximate indication of the rate of apparent photosynthesis. A directly proportionate loss of carbohydrates is inevitable in respiration, and since respiration increases rapidly with increase of temperature, whereas photosynthesis does not, a maintained high temperature may actually cause a loss of carbohydrate. This is clearly shown in the experiment at 95°F.

The results showed generally a rapid uptake of nitrogenous salts from the nutrient solution by the plants at all three temperatures, but, by contrast, the utilisation or assimilation of the absorbed nitrogen was rapid only at 95°F., less rapid at 70°F. and slow at 55°F. The corresponding effect on the carbohydrate reserves was also a rapid utilisation at the two higher temperatures, and a much slower one at 55°F. The plants not supplied with nitrogen acted as controls. Thus, at 55°F. with the N-free treatment there was a definite increase of carbohydrates over that found in the initial plants. Likewise at 70°F. with no external nitrogen supply, there was a gain in carbohydrate concentration but less than at 55°F. At 95°F. however there was a loss of carbohydrate, indicating an excess of respiration over photosynthesis at this temperature.

In the case of the plants supplied with nitrogen the results indicated a low nitrogen utilisation at 55°F., so that the growth was small and there was only a small decrease in the carbohydrate reserve. At 70°F. however nitrogen assimilation was rapid, resulting in considerable new succulent stem and leaf growth and a marked decrease in the carbohydrate reserves. It is necessary to distinguish between absorption and assimilation of nitrogen. Thus at all three temperatures the physical absorption of the nitrogen-containing

* Effects of Temperature on Metabolism in Tomato. *Bot. Gaz.* XCV, I, 1933.

* For a time the plant may maintain the protein demands of a young tissue such as the growing leader at the expense of older parts, such as the lower leaves, which lose nitrogen in consequence. This of course could not happen in a plant which had been under a prolonged treatment of nitrogen starvation such as the N-free plants in this experiment.

salt was very rapid, but the subsequent utilisation to form proteins and fresh living material varied greatly with the temperature. At 95°F. the plants supplied with nitrogen showed initially a very rapid assimilation of nitrogen and during four days the growth of new stem and leaves far exceeded in rate that of the N-treated plants at 70°F. and there was an extreme decline in carbohydrates, accompanying the rapid protein synthesis. After four days however the growth rate fell off. At the time of harvesting, some of the plants were dead at the stem tips, and plants kept for a further time at 95°F. and supplied with nitrogen all died within a few days, whereas by contrast the N-free plants showed no signs of death of stem-tips or other parts during the same period.

Discussion.—The results clearly show that the optimum temperature for vegetative growth in tomato plants lies well within the range 55°F. to 95°F., as at 55°F. nitrogen utilisation is low and at 95°F. carbohydrate accumulation is prevented by excessive respiration. The middle point of this range, 75°F., is a representative mean tropical temperature, and the experiments run at 70°F. suggested that this temperature is near the optimum for growth, as at 70°F. plants supplied with a complete nutrient solution were moderately high in carbohydrates, contained an abundance of elaborated nitrogen, were dark green, rather succulent, and grew vigorously. It is rather unfortunate that such a high temperature as 95°F. was selected as it is well above the normal daily mean temperature of tomato growing districts, and when maintained for several days is clearly harmful to the tomato plant. Physiological processes tend to become abnormal under continued high temperature and hence findings based on them are of less value than those obtained from experiments at somewhat lower temperatures. For tropical conditions the range 65° to 85°F. should provide useful data. The experiments were not continued to the flowering and fruiting stage, possibly owing to the considerations of space, but the effect of the interactions between nitrogen and carbohydrates upon the quantity and quality of the fruit should be of the greatest interest.

E. E. P.

REVIEWS.

The Marketing of Cotton.

By John A. Todd, M.A., B.L. *Sir Isaac Piman & Sons, Ltd.*, London, 194. pp. 250+ xxviii, price 10*s.* 6*d.*

The author has elaborated that section of his previous volume "The Cotton World" which dealt with the marketing process. In addition, he has brought this section up to date by dealing with the effect of the World depression on the cotton markets and the various remedies which have been attempted to overcome these difficulties.

Whilst a description of the intricacy of the Liverpool Cotton Exchange constitutes the main portion of this book, the earlier stages from the producer to the exporter receive due attention as do the American, Indian and Egyptian markets. The book therefore presents a complete picture of the cotton marketing process from the field to the factory.

Although this volume is primarily intended as a text book for students studying commerce in the North of England, it is of value as a study in supply and demand and of great interest to agriculturists who now must realise that their interests extend beyond the mere production of their crop.

This author undoubtedly gives one of the best pictures of the complexity of the operation of a modern market, and the explanation of "futures" and their effect on prices should be studied by all interested in the marketing of any crop which enters the World's markets. The speculator and middleman are frequently attacked but a perusal of this volume should convince many that they are cogs in a vast machine which, whilst not strictly productive fulfil a purpose which is essential to the smooth running of a vast industry.

A. W. P.

Virus Diseases of Plants.

By John Grainger, *Oxford University Press*, London, 1934; pp. 104. Price 6*s.*

In this work the author has aimed at producing a small and easily readable textbook on virus diseases for the use of students of Mycology and Plant Pathology at the Universities. No attempt is made to discuss fully the complex problems which have arisen in the investigation of these diseases. The author discusses briefly and concisely the history of virus diseases, the relation of the virus to its host plant, its properties *in vitro*, and its relation to insects. He mentions the difficulties encountered in any attempt made to classify this class of plant diseases and suggest methods for avoiding further confusion in this matter. Finally he gives a short account of the experimental methods used in the diagnosis of new virus diseases and in establishing the identity of their insect vectors. A useful bibliography is appended.

While this book only deals very briefly with this group of diseases, it should be valuable for providing a clear and interesting introduction to the subject to all who are meeting it for the first time.

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SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Experiments on Cane Juice Clarification.—*Wenceslao N. Tingson.*

Ten samples of mixed juice, each 1600 c.c. (one as control) were treated with increasing quantities of milk-of-lime at 14° Brix. In series 1 the pH values ranged from 5.5 to 9.8; series 2 from 5.8 to 11.8; series 3 from 5.4 to 9.9. This treatment was termed "toward alkalinity". Then the same mixed juice was heavily limed and 1600 c.c. samples treated with increasing quantities of acetic acid. In series 1 the pH values ranged from 4.8 to 9.8; series 2 from 5.6 to 9.9; series 3 from 5.2 to 9.4. This treatment was termed "back to acidity". All the treated samples were heated to boiling for 6.7 min., settled, decanted and analysed.

In the treatment "towards alkalinity", an increased treatment of lime, which correspondingly increased pH of the solution, increased the CaO in solution in the clarified juice, P_2O_5, SO_4, Al_2O_3, Fe_2O_3, and MgO being removed by precipitation.

The maximum increase of purity from mixed juice to clarified juice reached a limit at certain pH, and a further addition of lime did not bring any increase in purity. The Calamba Sugar Estate mixed juice attained the maximum purity for series 1 of 85.34° at pH 8.7 giving an increase of 4.16° over the control, the pH value of which was 5.5, and for series 2 of 87.94° at pH 10.1, giving an increase of 3.7° over the control, the pH of which was 5.8.

However, the percentage of glucose destroyed was 33.57 per cent. for series 1, and 27.4 for series 2. At pH 6.3 in series 1, the purity was 84.33°, or an increase of 3.15° over the control, the percentage of glucose destroyed being a minimum of 7.98 per cent. In series 2 at pH 7.7 the purity was 86.92°, or an increase of 2.68°, the glucose destroyed being 7.18 per cent. Crusher juice reached a maximum purity of 86.94° at pH 9.3, giving an increase of 0.74° over the control, the percentage of glucose destroyed being 25.65. At pH 7.5, the purity was 86.58° or an increase of 0.38°, glucose destroyed being 5.16 per cent.

When mixed and crusher juices were limed heavily to the highest pH, the percentage of the inorganic impurities were at a minimum, the percentage being lower than those of the control. But it was found that the addition of the acetic acid brought back into solution the precipitated inorganic substances, and also increased the amount of lime going into solution. As the result of the lime and the impurities going into solution the purity was lowered; hence, the ash of the "back to acidity" treatment increased from the highest to the lowest pH values.—(*Inter. Sugar Journ.*, Vol. XXXVI, No. 422, p. 85.)

Production of Absolute Alcohol by the Hiag Process.—*Dr. Ederer.*

A description of this process has already been published in this Journal*. At a recent meeting of the German Chemical Society held recently in Wurzberg the author gave some further particulars of the method of production employed in which solutions of readily fusible salts as sodium and potassium acetate form the dehydrating liquid.

Its principle consists in treating in counter-current the spirit to be dehydrated which may contain 90-96 per cent. by volume of alcohol. This is done in a Raschig-ring column with a solution of the salts just mentioned in absolute alcohol. In this way the salt solution running through the Raschig-ring column withdraws the water from the spirit collecting in the lowest part of the column. From thence it flows continuously into a smaller column, the alcohol in it being returned by way of a cooler to the dehydrating system. The aqueous salt solution remaining is continuously forced by a *montejus* into a reservoir which feeds a pan heated by superheated steam. There it is dehydrated at 260 to 300°C.

Following this operation, the water-free salt flows into a mixing vessel into which at the same time absolute alcohol flows from the cooler of the Raschig-ring column, solution there being effected. Then from the mixing vessel the anhydrous alcoholic salt solution flows into the Raschig-ring column, and the cycle of operations is repeated.

Whereas usually in the technique of alcohol production there is multiple circulation, the spirit sometimes being returned four and five times, this is not so in the Hiag process. It is on this fact that its heat economy depends. Only 65 kg. of steam are necessary for the production of 1 hl. of absolute alcohol from neutral 94 per cent. spirit, practically free from aldehyde and fusel oil. Loss of alcohol amounts to only 0.2 to 0.4 per cent. In the case of 10 per cent. mash heated to 80°C., the amount of steam necessary is 300 kg., on the same basis.

It is stated that the Hiag process has been introduced into many distilleries in Germany and in other countries. Its favourable development has been due to the simplicity of its equipment and operation; to its low steam and water requirements; to its safety in working; and to its very small losses in dehydrating medium and in alcohol. A special advantage is the quality of its absolute alcohol, which can be used, not only as a motor fuel, but also for the pharmaceutical industry, for perfumery, and for the production of alcoholic drinks.—(*Int. Sugar Journal*, Vol. XXXVI, No. 423, March, pp. 125-126.)

* I.S.J., 1933, pp. 266-268.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Plant Disease and Manurial Treatment.

A definite correlation between the incidence of a plant disease and the type of manurial treatment applied is not of frequent occurrence, but it appears to be the case with a wilt, *Fusarium vasinfectum*, Atk., of the pigeon pea, *Cajanus indicus*, Spreng. This plant, commonly known as *rahar* in northern India, is included in the crop rotation grown on the permanent manurial plots at the agricultural farm at Pusa. W. McRae and F. J. F. Shaw have made a statistical study of the incidence of wilt on these and a number of other plots at the farm, and their results are published as Scientific Monograph No. 7, issued by the Imperial Council of Agricultural Research, Delhi. The disease was found to cause an average loss of ten per cent. of the plants, but neither the moisture content nor the hydrogen-ion concentration of the soil was found to be the controlling factor. Manuring with superphosphate or with cattle manure, on the other hand, resulted in an increase in wilt, whereas green manuring (*Crotalaria juncea*) had the reverse effect and reduced the disease. A combination of superphosphate and green manure, however, brought about an increase in the number of plants affected. Several types resistant to this disease have been isolated, the factor for resistance showing no correlation with any of the morphological characters studied. An interesting feature in this breeding work was the discovery that resistance was lost in a field which had been under *rahar* for a number of years. Such a loss, however, was not transmitted to the next generation, only the soma of the plant being affected.—(*Nature*, No. 3359, Vol. CXXXIII, p. 420.)

* * *

Cashew Oil.

A non-drying oil obtained from the shell of the cashew nut has interesting properties in connection with coatings and mouldings. When heated to a high temperature it forms a gel, being similar in this respect to tung oil. With formaldehyde it forms a resin. Varnishes made from this cashew liquid, which are marketed as Harvel, are very resistant to acids and alkalies, and possess unusual resistance to the softening action of mineral oils. These varnishes have been used for the impregnation of paper from which screw-cap washers for bottles are cut, for coating racks for plating and acid baths, and in paints for concrete garage and cellar floors.—(*Ind. and Engin. Chem.*, Vol. 26, No. 1, 1934, p. 40.)

* * *

Cod Liver Oil and Cocoa.

Wentworth, of New Brunswick, has found that fresh cod livers can be mixed with cocoa in such a manner that the health-promoting properties of the livers can be presented without oiliness or objectionable taste or odour. Small chocolate bars containing the equivalent of a tablespoonful of cod liver oil have been made and mixtures of cod livers with cocoa have been used for making ice-cream and milk and egg shakes. It is claimed that there is no impairment of the livers by chemical or physical change. The Canadian experimenters have found that by their method the activity is retained for at least twelve months. The process is simple. The livers are freed from extraneous matter and finely minced after which they are mixed with cocoa in definite proportions. The resultant heavy dough is milled and the mixture, on leaving the rolls, looks just like ordinary cocoa. Apparently no rancidity occurs, which is rather remarkable. It is now being marketed as a powder and also in the form of chocolate candy bars.—(*Proceedings of the Agricultural Society of Trinidad and Tobago*, Vol. XXXIV, pt. 3.)

* * *

Citric Acid from Tobacco.

At the Panunion Institute of the Tobacco Industry of Soviet Russia interesting research has been carried out showing that tobaccos of inferior quality, and more especially the 'Makhorka,' are very rich in citric acid. This tobacco contains from six to eight per cent., whereas the citron contains about six per cent. Experiments carried out at the Institute of Krasnodar in a plant of semi-industrial character established for the purpose, prove that citric acid may be recovered from the waste of Makhorka tobacco in an economical and profitable manner, for the whole of the acid may be recovered after the extraction of the nicotine, in which this tobacco is rich, better than by treating the tobacco directly.—(*International Review of Agriculture*, Year XXV, No. 1, January, 1934, p. 45 T.)

* * *

Chemical Composition of the Mango.

The chemical composition of the fresh pulp of mango fruit has been determined by R. Yamamoto, Y. Osima and T. Goma (Tokyo Institute, Scientific Papers, 1932, Vol. 19, p. 122), who have reported the following data. The water content of the pulp is 81.7 per cent., and the sugars consist of sucrose (5.5), fructose (4.9), and glucose (1.5). The acidic taste is due to citric acid (0.5), and the yellow colour, to xanthophyll (0.9) and carotene (0.1). The last-named substance, isolated from mango fruits, was found to cure avitaminosis-A in rats, and therefore confers a valuable food property on the fruits.—(*British Chemical Abstracts*, (A), Nov., 1932, p. 1178.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR:—Prices on the Home Market have ranged as follows (c.i.f. per cwt.):—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
22nd February	5	3	10	0
1st March	5	1½	9	10½
8th March	5	1½	9	10½
15th March	5	1½	9	10½
22nd March	5	0¾	9	7½
29th March	4	10½	9	7½
5th April	5	3	9	4½
12th April	5	3	9	4½
(*12th April*, 1933)....	5	9	10	6

Since our last report the market has tended towards lower levels. The delay in reaching agreement on the new Sugar Bill to be passed in the United States has been partly responsible for heavy liquidations and a decline in prices while the existence of stocks accumulated during the recent period of heavy arrivals of domestic sugar and, in the case of the United Kingdom, of preferential raws has checked activity considerably in the world's open market.

* * *

BANANAS.—Jamaicas have remained in fairly good demand and the wholesale prices of both the Jamaica Producers and Elders and Fyffes are unchanged at £19 5*s*. per ton delivered London and £19 nearest station provinces. Brazilians are in better demand and the quotation is 10*s*. per ton higher at £17 10*s*.—(*West India Committee Circular*, 15th March.)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

	d.
28th February	4 15-16
7th March	4 15-16
14th March	5 13-32
21st March	5 1-8
28th March	5 3-16
4th April	5 5-16
11th April	5 19-32
(*12th April*, 1933)	2 9-32

The rubber market has generally been active mainly under the influence of further conflicting restriction rumours. Another unsettling feature has been the threat of a strike in the U.S.A. motor industry. Total consumption of rubber for the months of January and February comes to 81,022 tons which compares with a total of 42,123 tons for the same two months last year. The increase is due to the revival of the motor trade in U.S.A., which is also taking place in European countries, notably Germany.

COCOA.—Generally the cocoa market has been easier on account of shipments from the Gold Coast to middle of March being 3,707 tons ahead of the previous period, namely, 1st October to mid-March. Accra fair fermented is quoted at 24*s*. to 25*s*. and locally $7.00 to $7.10 a fanega is paid for Plantation cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:—

	American Mid.	*Egyptian F.G.F. Sakel.*
23rd February	6.67	9.11
2nd March	6.55	8.96
9th March	6.65	8.99
16th March	6.62	8.85
23rd March	6.43	—
31st March	6.35	—
7th April	6.40	—
(*7th April*, 1933)	5.28	7.27

The American cotton market has generally remained steady in spite of unfavourable conditions including the delay over the passage of the Bankhead Bill through the U.S.A. House of Representatives, the revival of the Soldiers' Bonus Bill and labour troubles. Good business has been done in West Indian Sea Island, sales including Montserrat, Nevis, Antigua, St. Kitts and St. Vincent at 13*d*. to 16*d*. and a few stains at 8*d*. to 9*d*.

* * *

COFFEE.—The market has been quieter, fine liquoring sorts making steady rates. Latest quotations per cwt. include Costa Rica, London, cleaned, bold to fine bold colony, 93*s*. to 147*s*.; Kenya bold grey-greenish and greenish 63*s*. to 139*s*.; Santos 48*s*. 6*d*.

* * *

COPRA.—Is inactive and West Indian f.m.s. is unchanged at £9 12*s*. 6*d*. c.i.f. United Kingdom for March-April shipment.—(*West India Committee Circular*, 15th March.)

* * *

GRAPEFRUIT.—The average prices ruling in Covent Garden for the week ended 10th March, according to count and condition were:

	s.	*d.*		*s.*	*d.*
Jamaica	8	0	to	14	0
Trinidad	10	0	,,	19	0
Spain	9	6	,,	11	6
Florida	13	6	,,	17	0
Puerto Rico	12	9	,,	18	0
Palestine	12	6	,,	19	0

—(*West India Committee Circular*, 15th March.)